

**UNCLASSIFIED**

**AD NUMBER**

**AD813481**

**LIMITATION CHANGES**

**TO:**

**Approved for public release; distribution is unlimited.**

**FROM:**

**Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; DEC 1966. Other requests shall be referred to Air Force Technical Application Center, Washington, DC. This document contains export-controlled technical data.**

**AUTHORITY**

**onr ltr, 28 jul 1977**

**THIS PAGE IS UNCLASSIFIED**

GREELEY

AD 813481

LONG RANGE SEISMIC MEASUREMENTS

# GREELEY

20 DECEMBER 1966

Prepared for

AIR FORCE TECHNICAL APPLICATIONS CENTER

Washington, D. C.

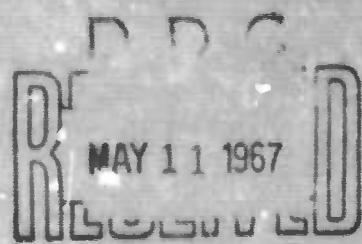
28 APRIL 1967

By

TELEDYNE INC.

Under

Project VELA UNIFORM



Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY

Nuclear Test Detection Office

ARPA Order No. 624

# **DISCLAIMER NOTICE**

**THIS DOCUMENT IS THE BEST  
QUALITY AVAILABLE.**

**COPY FURNISHED CONTAINED  
A SIGNIFICANT NUMBER OF  
PAGES WHICH DO NOT  
REPRODUCE LEGIBLY.**

LONG RANGE SEISMIC MEASUREMENTS

GREELEY

20 December 1966

SEISMIC DATA LABORATORY REPORT NO. 180

|                           |                                   |
|---------------------------|-----------------------------------|
| AFTAC Project No.:        | VELA T/6702                       |
| Project Title:            | Seismic Data Laboratory           |
| ARPA Order No.:           | 624                               |
| ARPA Program Code No.:    | 5810                              |
| Name of Contractor:       | TELEDYNE, INC.                    |
| Contract No.:             | F 33657-67-C-1313                 |
| Date of Contract:         | 3 March 1967                      |
| Amount of Contract:       | \$ 1,735,617                      |
| Contract Expiration Date: | 2 March 1968                      |
| Project Manager           | William C. Dean<br>(703) 836-7644 |

P. O. Box 334, Alexandria, Virginia

AVAILABILITY

This document is subject to special export controls and each transmittal to foreign governments or foreign national may be made only with prior approval of Chief, AFTAC.

This research was supported by the Advanced Research Projects Agency, Nuclear Test Detection Office, under Project VELA-UNIFORM and accomplished under the technical direction of the Air Force Technical Applications Center under Contract F 33657-67-C-1313.

Neither the Advanced Research Projects Agency nor the Air Force Technical Applications Center will be responsible for information contained herein which may have been supplied by other organizations or contractors, and this document is subject to later revision as may be necessary.

## TABLE OF CONTENTS

|                               | Page No.  |
|-------------------------------|---|
| EVENT DESCRIPTION             | 1   |
| INTRODUCTION                  | 2   |
| INSTRUMENTATION AND PROCEDURE | 3   |
| DATA AND RESULTS              | 5   |
| <u>TABLES</u>                 |   |
| 1                             | Station Status Report - GREELEY                 |
| 2                             | Principal Phases - GREELEY                      |
| <u>FIGURES</u>                |   |
| 1                             | Recording Stations and Signals Received         |
| 2                             | Unified Magnitudes                              |
| 3                             | Adjusted Unified Magnitudes                     |
| 4                             | Travel-Time Residuals, $T-\Delta/8.1$ ; T-JB    |
| 5                             | Maximum Amplitudes of Pn and P                  |
| 6                             | Maximum Amplitudes of Pg                        |
| 7                             | Maximum Amplitudes of Lg                        |
| 8                             | Maximum Amplitudes of LQ                        |
| 9                             | Maximum Amplitudes of LR                        |
| <u>LIST OF APPENDICES</u>     |   |
| I(A)                          | Recording Site Information                      |
| I(B)                          | Unified Magnitudes from Pn or P Waves           |
| II(A)                         | Seismic Analysis Diagram                        |
| II(B)                         | Instrument Response Curves - LRSM               |
| II(C)                         | Instrument Response Curves - Other Short Period |
| II(D)                         | Instrument Response Curves - LASA               |

GREELEY

EVENT DESCRIPTION

DATE: 20 December 1966

TIME OF ORIGIN: 15:30:00.12

YIELD:

MAGNITUDE: 6.29 ± 0.45

LOCATION:

SITE: Nevada Test Site, Area U20g

GEOGRAPHIC COORDINATES:

Lat: 37°18'07.0" N

Long: 116°24'30.0" W

ENVIRONMENT:

GEOLOGIC MEDIUM: ZEOLITIZED TUFF

surface ELEVATION: 6470 ft.

SHOT ELEVATION: 2430 ft.

SHOT DEPTH: 4040 ft.

COMPUTED EPICENTER:

ALL STATIONS

GEOGRAPHIC COORDINATES:

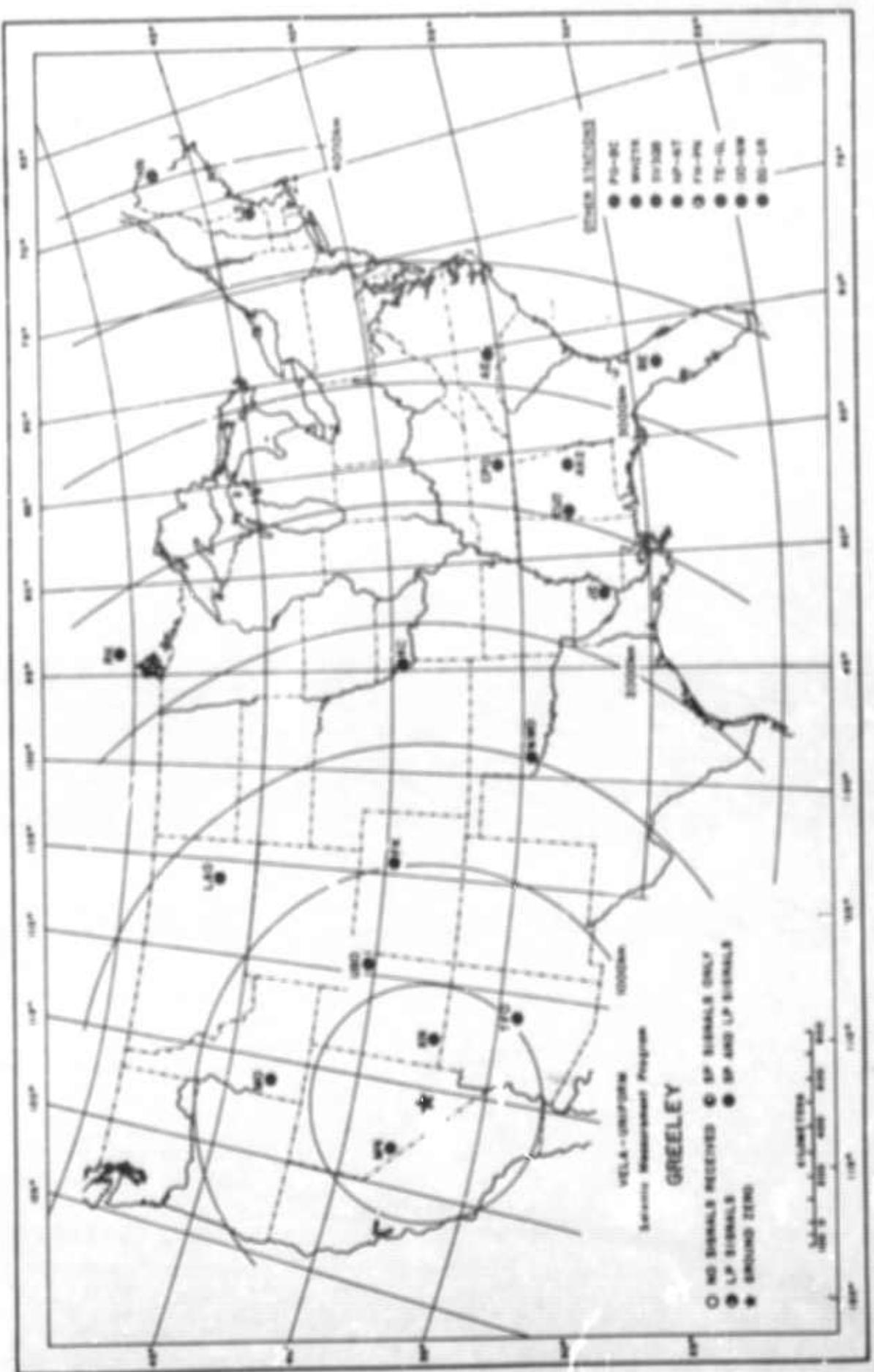
Lat: 37°14'56.4" N

Long: 116°31'44.4" W

TIME OF ORIGIN: 15:30:00.4

DEPTH CONSTRAINED TO: 0 km

EPICENTER SHIFT: 12.2 km, S 61° W



Page 3

Recording stations and signals received.

## INTRODUCTION

A long range seismic measurements (LRSM) program and several larger seismographic observatories were established under VELA-UNIFORM to record seismological data resulting from natural seismic activity and a planned series of U. S. underground nuclear tests. The LRSM teams are mobile and occupy locations selected to provide optimum data from events of special interest; the observatories are permanent installations as follows:

**Wichita Mountains Seismological Observatory (WMSO)**  
Lawton, Oklahoma

**Vintz Basin Seismological Observatory (VBSO)**  
Vernal, Utah

**Cumberland Plateau Seismological Observatory (CPSO)**  
McMinnville, Tennessee

**Tonto Forest Seismological Observatory (TFSO)**  
Payson, Arizona

**Large Aperture Seismic Array (LASA)**  
Billings, Montana

The purpose of this report is to provide an analysis of data resulting from the GREELEY event recorded by the LRSM teams and the VELA observatories and a preliminary summary of data reported by other permanent and temporary seismographic stations.

## INSTRUMENTATION AND PROCEDURE

The instrumentation at each of the LRSN locations consists of three-component short-period and three-component long-period seismographs. In general, data are recorded on 35 millimeter film and on one-inch 14 channel magnetic tape, although recently more portable instrumentation has been incorporated which records only on magnetic tape. The stations are all equipped to record continuously to provide accurate time control and calibration is accomplished once each day and just prior to each shot at the operational settings. Pertinent information useful for analysis of LRSN data is available to qualified users of this data and is contained in Technical Report 65-43, "Interpretation and Usage of Seismic Data, LRSN program." General information on LRSN van and portable system equipment and operation is given in Technical Report 66-27, "The LRSN Mobile Seismological Laboratory," and 66-74, "A Portable Seismograph." Copies of these reports may be obtained from DDC. The AD control number of Technical Report 66-27 is 480341. All the observatories have both long-period and short-period, three-component instrumentation, in addition to their other specialized facilities.

Station information is presented in Appendix I. This includes the station name and code; the geographic coordinates,

distances and azimuths involved; the station elevations; and the type of instruments in use at each location. Representative instrumental response curves are shown in Appendix II(B) and II(C).

The procedures used in measuring amplitudes reported herein are illustrated in Appendix II(A) and the unified magnitude is calculated as shown in Appendix I(B). The distance factors (B) beyond  $16^{\circ}$  are from Gutenberg and Richter\*. For distances less than  $16^{\circ}$  values were read from a curve in the Gutenberg and Richter paper back to  $10^{\circ}$  and then extrapolated to  $2^{\circ}$ , using an inverse cube relationship. An additional magnitude for less than  $16^{\circ}$  was computed using a method described by Evernden\*\*. (Figure 3).

A standard hypocenter location program for a digital computer is used to determine the location using data from all stations analyzed. Best-fit values of latitude, longitude, and time of origin are determined statistically by a least squares technique. This utilizes a Jeffreys-Bullen travel-time curve as modified by Herrin in 1961 on the basis of Pacific surface-focus recordings. Precision of the computation is limited primarily by the accuracy of arrival times, the validity of the standard travel-time curve, and by local velocity deviations. This method is based on P-wave

\* Gutenberg, B. and Richter, C. F., Magnitude and Energy of Earthquakes, Ann. Geofis., 9 (1956), pp. 1-15

\*\* Evernden, J. F., Magnitude Determination at Regional and Near Regional Distances in the United States, APTAC/VELA Seismological Center Technical Report VU-65-4A, (1965), pp.6, 13

arrivals with the depth constrained to zero.

#### DATA AND RESULTS (LRSM AND VELA OBSERVATORIES)

The parameters of the GREELEY event and a summary of the seismic evaluation is shown on the Event Description page. The operational status of the 26 LRSM stations and observatories is given in Table 1 and illustrated in Figure 1.

Table 2 summarizes the measurements made of the principal phases from the GREELEY event at the LRSM and VELA stations. Included are the Pn and P arrival times, the maximum amplitudes (A/T) of Pn or P motion and other phases as seen on the short-period vertical instruments. Long-period Love and Rayleigh wave motion are also tabulated in (A/T) form. In addition, individual station Rayleigh wave areas ( $\text{mm}^2$ ) is indicated as measured on the LPZ only. Although reduced to 1K magnification, they have not been normalized to any magnitude. Twenty-five stations recorded short-period signals. Long-period signals from this event were recorded by 26 stations.

The unified magnitudes determined from the LRSM and VELA observatories is shown in Figure 2. The average magnitude is 6.29  $\pm$  0.45. The adjusted magnitude is 6.16  $\pm$  0.40 and is shown in

**Figure 3.**

The travel-time residuals from the Pn and P phases are shown in Figure 4. Figures 5 through 9 illustrate plots of the amplitudes of P, Pg, Lg, LQ, and LR.

Attached to the report are illustrative seismograms showing the signals recorded at 4 stations. The most distant station analyzed that recorded GREELEY was GG-GR at a distance of 0005 kilometers.

卷之三

卷之三

| Code    | Station                              | Distance<br>(km) | Instr.<br># | Magnetic<br>Declination<br>(h)<br>Film = 10 | Phone | Observed<br>Transit Time |       | Mean Time<br>A.T.P. |           | Mean Time<br>L.P. |       | Mean Time<br>L.P. |
|---------|--------------------------------------|------------------|-------------|---|-------|--------------------------|-------|---------------------|-----------|-------------------|-------|-------------------|
|         |                                      |                  |             |   |       | Total                    | (sec) | Total               | (sec)     | Total             | (sec) |                   |
| 999-007 | Mesa, Arizona                        | 100              | 872         | 0.17  | 90    | 6                        | 31.7  | 0.4                 | 28.90     | 0.42              | 27.75 |                   |
|         |                                      |                  | 872         | 0.048                                       | 90    | 0                        | 33.1  | 0.4                 | 37.07(94) | 0.4               | 36.95 |                   |
|         |                                      |                  | 872         | 0.174                                       | 90    |                          |       | 31.0                | 30.97(5)  |                   |       |                   |
|         |                                      |                  | 872         | 0.07  | 90    |                          |       | 31.0                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.036                                       | 90    |                          |       | 31.0                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.116                                       | 90    | 0                        | 49.0  | 0.4                 | 49.20     | 0.40              | 48.44 |                   |
|         |                                      |                  | 872         | 0.116                                       | 90    | 0                        | 33.2  | 0.35                | 34.70     | 0.35              | 34.50 |                   |
|         |                                      |                  | 872         | 0.143                                       | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.07  | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.049                                       | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 19.7  | 0.4                 | 19.90     | 0.40              | 19.84 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 27.1  | 0.5                 | 26.90     | 0.50              | 26.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 35.2  | 0.7                 | 33.14     | 0.70              | 32.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 31.4  | 0.4                 | 31.00     | 0.40              | 30.80 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 31.7  | 0.4                 | 30.90     | 0.40              | 30.70 |                   |
| 999-017 | Mesa, Arizona                        | 100              | 872         | 0.17  | 90    | 1                        | 31.7  | 0.4                 | 28.90     | 0.42              | 27.75 |                   |
|         |                                      |                  | 872         | 0.048                                       | 90    | 0                        | 33.1  | 0.4                 | 37.07(94) | 0.4               | 36.95 |                   |
|         |                                      |                  | 872         | 0.174                                       | 90    |                          |       | 31.0                | 30.97(5)  |                   |       |                   |
|         |                                      |                  | 872         | 0.07  | 90    |                          |       | 31.0                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.036                                       | 90    |                          |       | 31.0                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.116                                       | 90    | 0                        | 49.0  | 0.4                 | 49.20     | 0.40              | 48.44 |                   |
|         |                                      |                  | 872         | 0.116                                       | 90    | 0                        | 33.2  | 0.35                | 34.70     | 0.35              | 34.50 |                   |
|         |                                      |                  | 872         | 0.143                                       | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.07  | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.049                                       | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    |                          |       | 31.2                | 31.00     |                   |       |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 19.7  | 0.4                 | 19.90     | 0.40              | 19.84 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 27.1  | 0.5                 | 26.90     | 0.50              | 26.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 35.2  | 0.7                 | 33.14     | 0.70              | 32.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 31.4  | 0.4                 | 31.00     | 0.40              | 30.80 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 31.7  | 0.4                 | 30.90     | 0.40              | 30.70 |                   |
| 999-020 | Tonto Forest<br>Observatory, Arizona | 572              | 872         | 0.17  | 90    | 1                        | 19.7  | 0.4                 | 19.90     | 0.40              | 19.84 |                   |
|         |                                      |                  | 872         | 0.048                                       | 90    | 1                        | 27.1  | 0.5                 | 26.90     | 0.50              | 26.70 |                   |
|         |                                      |                  | 872         | 0.174                                       | 90    | 1                        | 35.2  | 0.7                 | 33.14     | 0.70              | 32.90 |                   |
|         |                                      |                  | 872         | 0.07  | 90    | 1                        | 31.4  | 0.4                 | 31.00     | 0.40              | 30.80 |                   |
|         |                                      |                  | 872         | 0.036                                       | 90    | 1                        | 31.7  | 0.4                 | 30.90     | 0.40              | 30.70 |                   |
|         |                                      |                  | 872         | 0.116                                       | 90    | 1                        | 29.4  | 0.4                 | 29.60     | 0.40              | 29.44 |                   |
|         |                                      |                  | 872         | 0.116                                       | 90    | 1                        | 37.5  | 0.7                 | 35.30     | 0.70              | 35.10 |                   |
|         |                                      |                  | 872         | 0.143                                       | 90    | 1                        | 33.6  | 0.6                 | 32.40     | 0.60              | 32.20 |                   |
|         |                                      |                  | 872         | 0.07  | 90    | 1                        | 33.9  | 0.6                 | 32.70     | 0.60              | 32.50 |                   |
|         |                                      |                  | 872         | 0.049                                       | 90    | 1                        | 34.2  | 0.6                 | 33.00     | 0.60              | 32.80 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 34.5  | 0.6                 | 32.80     | 0.60              | 32.60 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 34.8  | 0.6                 | 33.60     | 0.60              | 33.40 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 35.1  | 0.6                 | 34.40     | 0.60              | 34.20 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 35.4  | 0.6                 | 34.20     | 0.60              | 34.00 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 35.7  | 0.6                 | 35.50     | 0.60              | 35.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 36.0  | 0.6                 | 35.80     | 0.60              | 35.60 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 36.3  | 0.6                 | 35.60     | 0.60              | 35.40 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 36.6  | 0.6                 | 35.40     | 0.60              | 35.20 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 36.9  | 0.6                 | 35.20     | 0.60              | 35.00 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 37.2  | 0.6                 | 36.00     | 0.60              | 35.80 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 37.5  | 0.6                 | 35.80     | 0.60              | 35.60 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 37.8  | 0.6                 | 36.60     | 0.60              | 36.40 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 38.1  | 0.6                 | 36.40     | 0.60              | 36.20 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 38.4  | 0.6                 | 37.20     | 0.60              | 37.00 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 38.7  | 0.6                 | 37.00     | 0.60              | 36.80 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 39.0  | 0.6                 | 37.80     | 0.60              | 37.60 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 39.3  | 0.6                 | 38.60     | 0.60              | 38.40 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 39.6  | 0.6                 | 38.40     | 0.60              | 38.20 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 39.9  | 0.6                 | 38.20     | 0.60              | 38.00 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 40.2  | 0.6                 | 39.00     | 0.60              | 38.80 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 40.5  | 0.6                 | 38.80     | 0.60              | 38.60 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 40.8  | 0.6                 | 39.60     | 0.60              | 39.40 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 41.1  | 0.6                 | 39.40     | 0.60              | 39.20 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 41.4  | 0.6                 | 40.20     | 0.60              | 39.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 41.7  | 0.6                 | 39.00     | 0.60              | 38.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 42.0  | 0.6                 | 38.80     | 0.60              | 38.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 42.3  | 0.6                 | 38.60     | 0.60              | 38.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 42.6  | 0.6                 | 38.40     | 0.60              | 38.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 42.9  | 0.6                 | 38.20     | 0.60              | 37.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 43.2  | 0.6                 | 38.00     | 0.60              | 37.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 43.5  | 0.6                 | 37.80     | 0.60              | 37.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 43.8  | 0.6                 | 37.60     | 0.60              | 37.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 44.1  | 0.6                 | 37.40     | 0.60              | 37.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 44.4  | 0.6                 | 37.20     | 0.60              | 36.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 44.7  | 0.6                 | 37.00     | 0.60              | 36.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 45.0  | 0.6                 | 36.80     | 0.60              | 36.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 45.3  | 0.6                 | 36.60     | 0.60              | 36.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 45.6  | 0.6                 | 36.40     | 0.60              | 36.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 45.9  | 0.6                 | 36.20     | 0.60              | 35.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 46.2  | 0.6                 | 36.00     | 0.60              | 35.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 46.5  | 0.6                 | 35.80     | 0.60              | 35.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 46.8  | 0.6                 | 35.60     | 0.60              | 35.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 47.1  | 0.6                 | 35.40     | 0.60              | 35.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 47.4  | 0.6                 | 35.20     | 0.60              | 34.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 47.7  | 0.6                 | 35.00     | 0.60              | 34.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 48.0  | 0.6                 | 34.80     | 0.60              | 34.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 48.3  | 0.6                 | 34.60     | 0.60              | 34.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 48.6  | 0.6                 | 34.40     | 0.60              | 34.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 48.9  | 0.6                 | 34.20     | 0.60              | 33.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 49.2  | 0.6                 | 34.00     | 0.60              | 33.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 49.5  | 0.6                 | 33.80     | 0.60              | 33.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 49.8  | 0.6                 | 33.60     | 0.60              | 33.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 50.1  | 0.6                 | 33.40     | 0.60              | 33.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 50.4  | 0.6                 | 33.20     | 0.60              | 32.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 50.7  | 0.6                 | 33.00     | 0.60              | 32.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 51.0  | 0.6                 | 32.80     | 0.60              | 32.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 51.3  | 0.6                 | 32.60     | 0.60              | 32.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 51.6  | 0.6                 | 32.40     | 0.60              | 32.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 51.9  | 0.6                 | 32.20     | 0.60              | 31.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 52.2  | 0.6                 | 32.00     | 0.60              | 31.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 52.5  | 0.6                 | 31.80     | 0.60              | 31.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 52.8  | 0.6                 | 31.60     | 0.60              | 31.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 53.1  | 0.6                 | 31.40     | 0.60              | 31.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 53.4  | 0.6                 | 31.20     | 0.60              | 30.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 53.7  | 0.6                 | 31.00     | 0.60              | 30.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 54.0  | 0.6                 | 30.80     | 0.60              | 30.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 54.3  | 0.6                 | 30.60     | 0.60              | 30.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 54.6  | 0.6                 | 30.40     | 0.60              | 30.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 54.9  | 0.6                 | 30.20     | 0.60              | 29.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 55.2  | 0.6                 | 30.00     | 0.60              | 29.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 55.5  | 0.6                 | 29.80     | 0.60              | 29.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 55.8  | 0.6                 | 29.60     | 0.60              | 29.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 56.1  | 0.6                 | 29.40     | 0.60              | 29.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 56.4  | 0.6                 | 29.20     | 0.60              | 28.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 56.7  | 0.6                 | 29.00     | 0.60              | 28.70 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 57.0  | 0.6                 | 28.80     | 0.60              | 28.50 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 57.3  | 0.6                 | 28.60     | 0.60              | 28.30 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 57.6  | 0.6                 | 28.40     | 0.60              | 28.10 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 57.9  | 0.6                 | 28.20     | 0.60              | 27.90 |                   |
|         |                                      |                  | 872         | 0.046                                       | 90    | 1                        | 58.2  | 0.6                 | 28.00     | 0.60              | 27.70 | </td              |

## **Principal Phases - GREELEY**

Table 2 page 1

115,30,00 Bremen 1966  
Principia Mathematica

| Code   | Station                             | Distance<br>(km) | Inst. | Magnet-<br>ification<br>(k) | Phase | Observed<br>Travel Time |                | Maximum<br>Amplitude<br>A/T | Magnitude | Area (mm <sup>2</sup> ) |
|--------|-------------------------------------|------------------|-------|-----------------------------|-------|-------------------------|----------------|-----------------------------|-----------|-------------------------|
|        |                                     |                  |       |                             |       | min                     | sec            |                             |           |                         |
| AK-2AL | Alexander City, Alabama             | 2796             | LPE   | 0.25                        | LG    | 14.0                    | 164.5          | 4,560.00                    | 6.51      | (1521)                  |
|        |                                     |                  | LPZ   | 0.25                        | LR    |                         | 14.0           |                             |           |                         |
|        |                                     |                  | SPZ   | 12.5                        | P     |                         | 28.0           |                             |           |                         |
|        |                                     |                  | SPZ   | 12.5                        | e     |                         | 10.2<br>(1.3)  |                             |           |                         |
|        |                                     |                  | SPR   | 12.5                        | e     |                         | 38.1           |                             |           |                         |
|        |                                     |                  | S     | 6.14                        | S     | 1.2                     | 688            |                             |           |                         |
|        |                                     |                  | LPT   | 3.04                        | S     |                         | 55             |                             |           |                         |
|        |                                     |                  | SPR   | 12.8                        | S     |                         | 55             |                             |           |                         |
|        |                                     |                  | SPZ   | 12.8                        | LG    |                         | 17             |                             |           |                         |
|        |                                     |                  | SPT   | 12.7                        | LG    |                         | 152            |                             |           |                         |
| ME-2TK | Whitehorse, Yukon Territory, Canada | 2913             | LPR   | 6.14                        | LG    | 2.0                     | 236            | 5,491.45                    | 6.51      | (2472)                  |
|        |                                     |                  | LPT   | 3.04                        | LG    |                         | 21             |                             |           |                         |
|        |                                     |                  | LPZ   | 0.234                       | LG    |                         | 1127           |                             |           |                         |
|        |                                     |                  | SPT   | 16.7                        | P     |                         | 444            |                             |           |                         |
|        |                                     |                  | SPZ   | 16.7                        | e     |                         | (2.4)<br>(974) |                             |           |                         |
|        |                                     |                  | SPT   | 17.1                        | LG    |                         | 23             |                             |           |                         |
|        |                                     |                  | LPT   | 1.08                        | LG    |                         | 599            |                             |           |                         |
|        |                                     |                  | LPZ   | 1.41                        | LG    |                         | 16)            |                             |           |                         |
|        |                                     |                  | SPT   | 21.5                        | P     | 1.0                     | 135            |                             |           |                         |
|        |                                     |                  | SPZ   | 21.0                        | e     |                         | 38.7           |                             |           |                         |
| AE-NC  | Albemarle, North Carolina           | 3249             | SPR   | 21.5                        | LG    |                         | 0.9<br>(126)   |                             |           |                         |
|        |                                     |                  | SPZ   | 17.0                        | LG    |                         | 2.6            |                             |           |                         |
|        |                                     |                  | SPT   | 1.32*                       | LG    |                         | 18             |                             |           |                         |
|        |                                     |                  | LPT   | 1.24*                       | LG    |                         | 2348           |                             |           |                         |
|        |                                     |                  | LPZ   | 1.41                        | LG    |                         | 4348           |                             |           |                         |
|        |                                     |                  | SPT   | 21.5                        | P     | 1.3                     | 552            | 6.51                        | 6.34      | (2472)                  |
|        |                                     |                  | SPZ   | 21.0                        | e     |                         | 19.3           |                             |           |                         |
|        |                                     |                  | SPR   | 21.5                        | e     |                         | 49.2           |                             |           |                         |
|        |                                     |                  | SPT   | 17.0                        | LG    |                         | 1.2            |                             |           |                         |
|        |                                     |                  | LPT   | 1.32*                       | LG    |                         | 197            |                             |           |                         |
| BE-FL  | Bellevue, Florida                   | 3318             | SPZ   | 23.1                        | P     | 1.3                     | 651            |                             |           |                         |
|        |                                     |                  | SPZ   | 23.1                        | e     |                         | 16.2           |                             |           |                         |
|        |                                     |                  | SPZ   | 23.1                        | e     |                         | 26.3           |                             |           |                         |
|        |                                     |                  | SPZ   | 23.1                        | e     |                         | 42.4           |                             |           |                         |
|        |                                     |                  | SPZ   | 23.1                        | e     |                         | 70.5           |                             |           |                         |
|        |                                     |                  | SPZ   | 23.1                        | (PCP) | 1.6                     | 238            |                             |           |                         |
|        |                                     |                  | LPR   | 1.53                        | S     |                         | 28.1           |                             |           |                         |
|        |                                     |                  | LPT   | 1.0                         | S     |                         | 15             |                             |           |                         |
|        |                                     |                  | SPR   | 21.4                        | S     |                         | 20             |                             |           |                         |
|        |                                     |                  | SPT   | 20.8                        | LG    |                         | 102            |                             |           |                         |
| LS-NH  | Lisbon, New Hampshire               | 3798             | LPR   | 1.53                        | LG    | 1.8                     | 387            | 4,642.08                    | 6.43      | (2472)                  |
|        |                                     |                  | LPT   | 1.0                         | LG    |                         | 277            |                             |           |                         |
|        |                                     |                  | LPZ   | 1.83                        | LG    |                         | 17             |                             |           |                         |
|        |                                     |                  | SPT   | 25                          | P     |                         | 1088           |                             |           |                         |
|        |                                     |                  | SPZ   | 25.0                        | e     |                         | (17)           |                             |           |                         |
|        |                                     |                  | SPR   | 28.5                        | e     | 1.0                     | 241)           |                             |           |                         |
|        |                                     |                  | SPZ   | 25.0                        | e     |                         | 1961           |                             |           |                         |
|        |                                     |                  | SPT   | 35.5                        | LG    |                         | 515            |                             |           |                         |
|        |                                     |                  | LPT   | 0.36                        | LG    |                         | 530            |                             |           |                         |
|        |                                     |                  | LPZ   | 0.33                        | LG    |                         | 167            |                             |           |                         |
| HM-FE  | Houlton, Maine                      | 4062             | SPZ   | 17.7                        | P     | 1.0                     | 592            | 6.43                        | 6.42      | (2472)                  |
|        |                                     |                  | SPZ   | 17.7                        | e     |                         | 15.9           |                             |           |                         |
|        |                                     |                  | SPZ   | 17.7                        | PCP   |                         | 31.2           |                             |           |                         |
|        |                                     |                  | SPT   | 16.5                        | LG    |                         | 1.0            |                             |           |                         |
|        |                                     |                  | LPT   | 1.93                        | LG    |                         | 2225           |                             |           |                         |
|        |                                     |                  | LPZ   | 2.19                        | LG    |                         | 10             |                             |           |                         |
|        |                                     |                  | SPT   | 17.7                        | P     | 1.0                     | 6774           |                             |           |                         |
|        |                                     |                  | SPZ   | 17.7                        | e     |                         | 770            |                             |           |                         |
|        |                                     |                  | SPZ   | 17.7                        | PCP   |                         | 486            |                             |           |                         |
|        |                                     |                  | SPT   | 17.7                        | LG    |                         | 70.6           |                             |           |                         |
|        |                                     |                  | LPT   | 1.93                        | LG    |                         | 589            |                             |           |                         |
| HM-FE  | Houlton, Maine                      | 4062             | SPZ   | 17.7                        | P     | 1.0                     | 16.0           | 6.43                        | 6.42      | (2472)                  |
|        |                                     |                  | SPZ   | 17.7                        | e     |                         | 15.9           |                             |           |                         |
|        |                                     |                  | SPZ   | 17.7                        | PCP   |                         | 31.2           |                             |           |                         |
|        |                                     |                  | SPT   | 16.5                        | LG    |                         | 1.0            |                             |           |                         |
|        |                                     |                  | LPT   | 1.93                        | LG    |                         | 2064           |                             |           |                         |
|        |                                     |                  | LPZ   | 2.19                        | LG    |                         | 14.0           |                             |           |                         |
|        |                                     |                  | SPT   | 17.7                        | P     | 1.0                     | 14.0           |                             |           |                         |
|        |                                     |                  | SPZ   | 17.7                        | e     |                         | 48.2           |                             |           |                         |
|        |                                     |                  | SPZ   | 17.7                        | PCP   |                         | 9              |                             |           |                         |
|        |                                     |                  | SPT   | 16.5                        | LG    |                         | 1.0            |                             |           |                         |
|        |                                     |                  | LPT   | 1.93                        | LG    |                         | 16             |                             |           |                         |

|        |   |      |     |       |              |    |      |       |       |          |
|--------|---|------|-----|-------|--------------|----|------|-------|-------|----------|
| LS-NH  | Lisbon, New Hampshire                       | 3788 | SPZ | 25    | P            | 6  | 46.2 | 1.0   | 535   | 6.43     |
|        |   |      | SPZ | 25.0  | a            | 6  | 48.2 | 1.0   | 530   |          |
|        |   |      | SPR | 28.5  | e            | 6  | 56.2 | 1.0   | 167   |          |
|        |   |      | SPZ | 25.0  | a            | 7  | 69.4 | 1.4   | 357   |          |
|        |   |      | SPT | 35.5  | Lg           |    |      | 1.8   | 592   |          |
| EN-NE  | Houlton, Maine                              | 4082 | SPZ | 17.7  | P            | 7  | 08.9 | 1.1   | 770   | 6.42     |
|        |   |      | SPZ | 17.7  | e            | 7  | 15.9 | 1.2   | 486   |          |
|        |   |      | SPZ | 17.7  | PCP          | 9  | 31.2 | 1.0   | 70.6  |          |
|        |   |      | SPT | 16.5  | Lg           |    |      | 2.5   | 589   |          |
|        |   |      | LPT | 1.93  | LQ           |    |      | 16.0  | 2064  |          |
|        |   |      | LPZ | 2.19  | LR           |    |      | 14.0  | 898   |          |
| SV-30B | Schafferville, Quebec<br>Canada             | 4195 | SPZ | 15.6  | P            | 7  | 16.3 | (1.3) | (508) | 1.178.08 |
|        |   |      | SPZ | 15.6  | e            | 7  | 18.6 | 1.1   | 301   |          |
|        |   |      | SPZ |       | PP           | 8  | 45.2 | 1.2   | 397   |          |
|        |   |      | SPR | 16.5  | Lg           |    |      | 1.8   | 218   |          |
|        |   |      | SPT | 16.4  | Lg           |    |      | 1.8   | 176   |          |
|        |   |      | LPR | 7.65  | LQ           |    |      | 18.0  | 146   |          |
|        |   |      | LPT | 7.4   | LQ           |    |      | 17.0  | 145   |          |
|        |   |      | LPZ | 4.75  | (LR)         |    |      | 13    | 838   |          |
| NP-NT  | Mould Bay, Northwest<br>Territories, Canada | 4344 | SPZ |       | P            | 7  | 29.1 | ---   | ---   | 2,936.84 |
|        |   |      | SPZ | 76.6* | e            | 7  | 42.9 | 1.0   | 176   |          |
|        |   |      | SPZ | 236   | a            | 8  | 35.1 | 1.3   | 92.6  |          |
|        |   |      | SPZ |       | (PP)         | 8  | 57.0 | ---   | ---   |          |
|        |   |      | SPZ | 76.6* | (PP)         | 9  | 19.7 | 1.8   | 261   |          |
|        |   |      | SPZ | 76.6* | (PP)         | 9  | 39.7 | 1.0   | 97.9  |          |
|        |   |      | SPT | 121*  | Lg           |    |      | 2.6   | 793   |          |
|        |   |      | LPT |       | LQ           |    |      | ---   | ---   |          |
|        |   |      | LPZ | 0.88  | LR           |    |      | 13    | 780   |          |
| PH-FN  | Port Sherman, Panama                        | 4789 | LPT | 1.55  | LQ           |    |      | 22    | 138   |          |
|        |   |      | LPZ | 1.55  | LR           |    |      | 21    | 217   |          |
| TE-GL  | Thula, Greenland                            | 4956 | SPZ | 71    | P            | 8  | 12.8 | 1.4   | 152   | 1.246.97 |
|        |   |      | SPZ | 71    | (PP)         | 8  | 55.2 | 0.8   | 24.0  |          |
|        |   |      | SPT | 67    | Lg           |    |      | (1.7) | (231) |          |
|        |   |      | LPT | 1.48  | LQ           |    |      | 2.8   | 262   |          |
|        |   |      | LPZ | 1.72  | LR           |    |      | 17    | 925   |          |
| OO-NW  | Oslo, Norway                                | 5120 | SPZ | 58.5  | P            | 11 | 30.6 | 0.9   | 88.1  | 5.84     |
|        |   |      | SPZ | 58.5  | a            | 11 | 32.1 | 0.9   | 86.3  |          |
|        |   |      | SPZ | 58.5  | e            | 11 | 36.3 | 0.8   | 34.6  |          |
|        |   |      | SPZ | 58.5  | PCP          | 11 | 47.9 | 1.0   | 55.6  |          |
|        |   |      | SPZ | 58.5  | e            | 14 | 57.9 | 1.8   | 92.3  |          |
|        |   |      | LPZ | 13.2  | rannic<br>LR |    |      | 23    | 55.4  |          |
|        |   |      | LPZ | 13.2  | LR           |    |      | 19    | 129   |          |
| GG-GR  | Grafenberg, Germany                         | 9095 | SPZ | **    | P            | 12 |      |       | 21.1  | 461.36   |
|        |   |      | LPZ | **    | LR           |    |      |       |       |          |

**M<sub>t</sub>** mi/sec

- (1) Doubtful Values or Phases
- \* Measurements Made from PI.
- Maximum Amplitude Changes

Magnification not available

\*\* Magnification not available

Table 2 Page 2

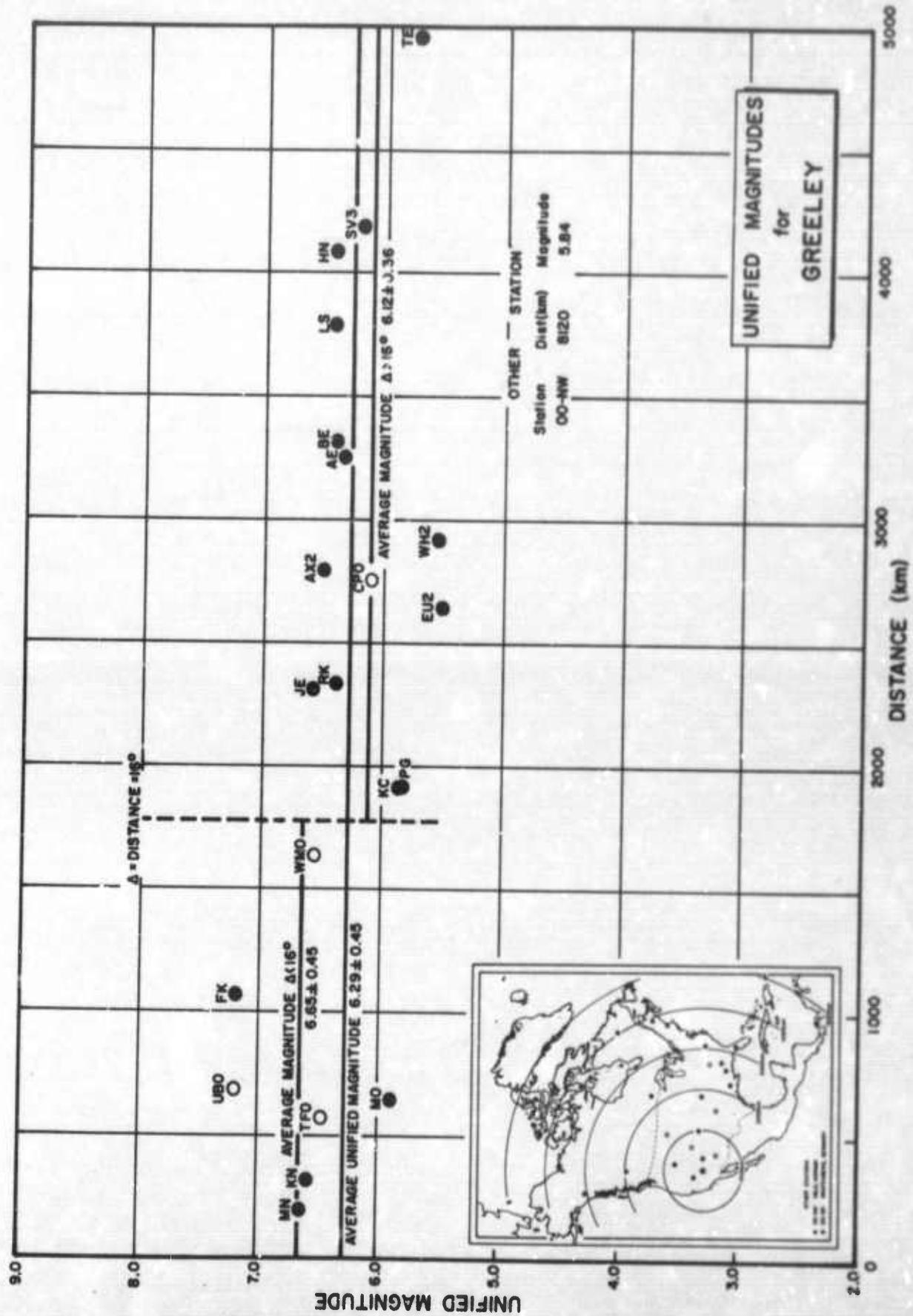
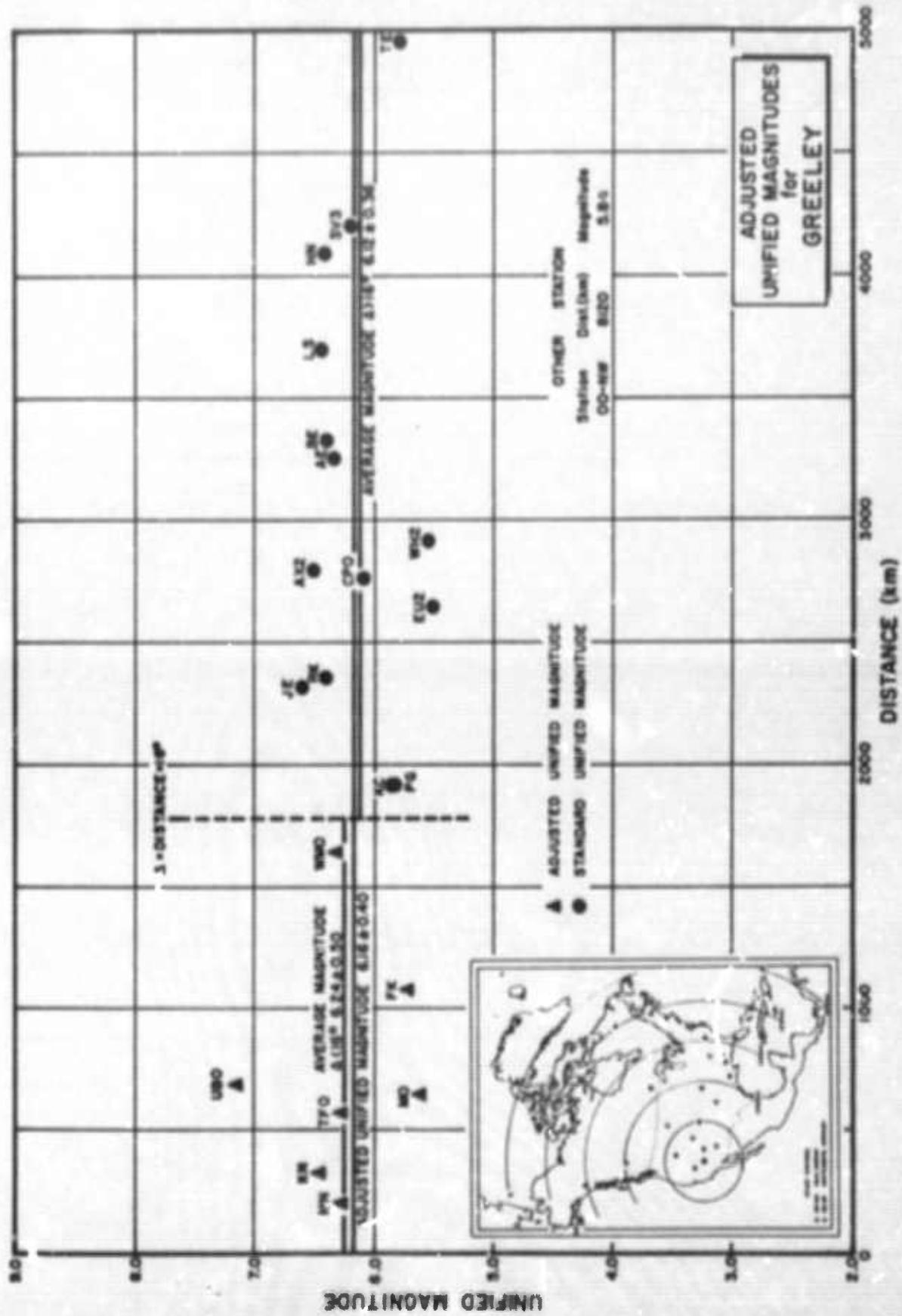


Figure 2



三

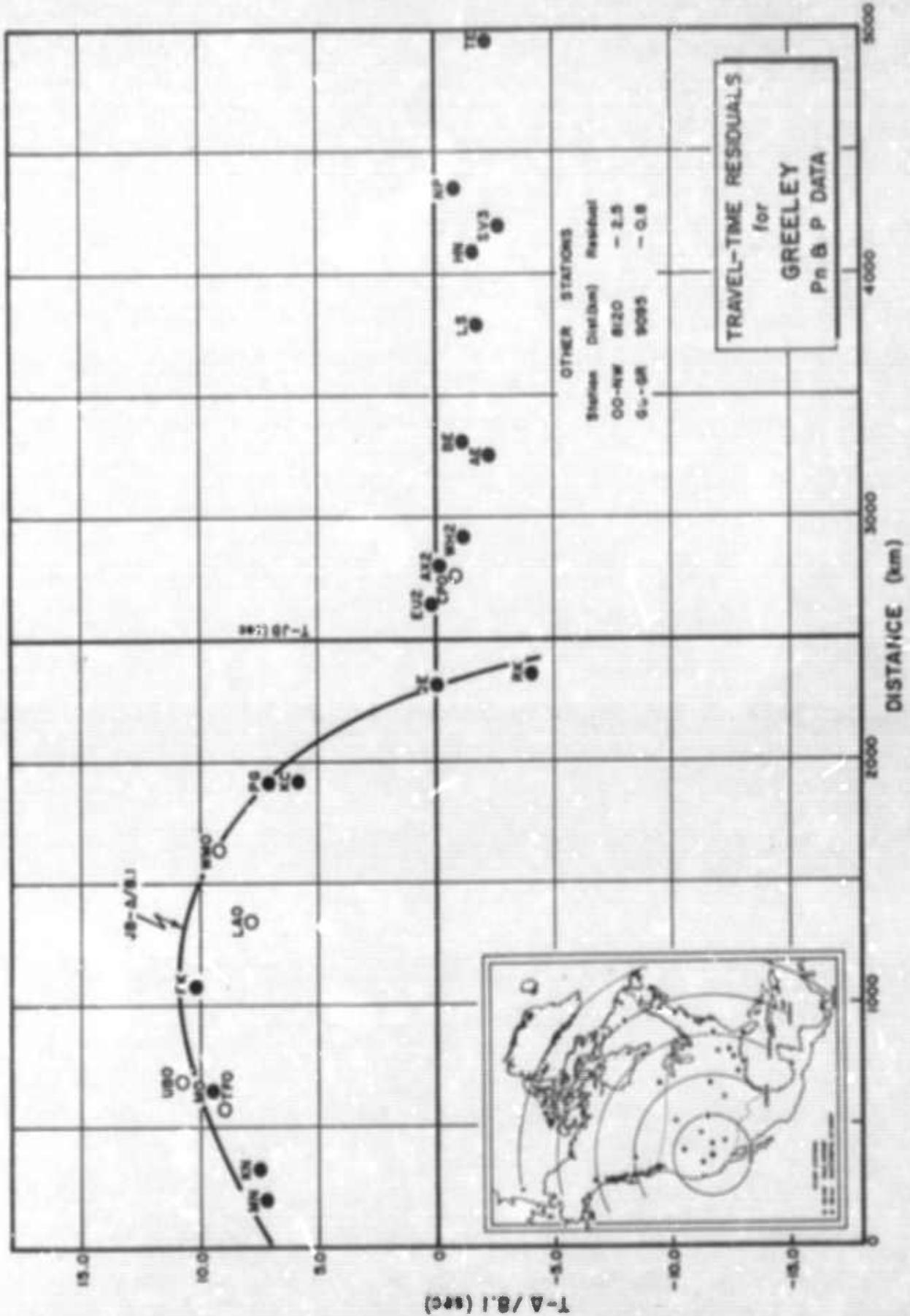
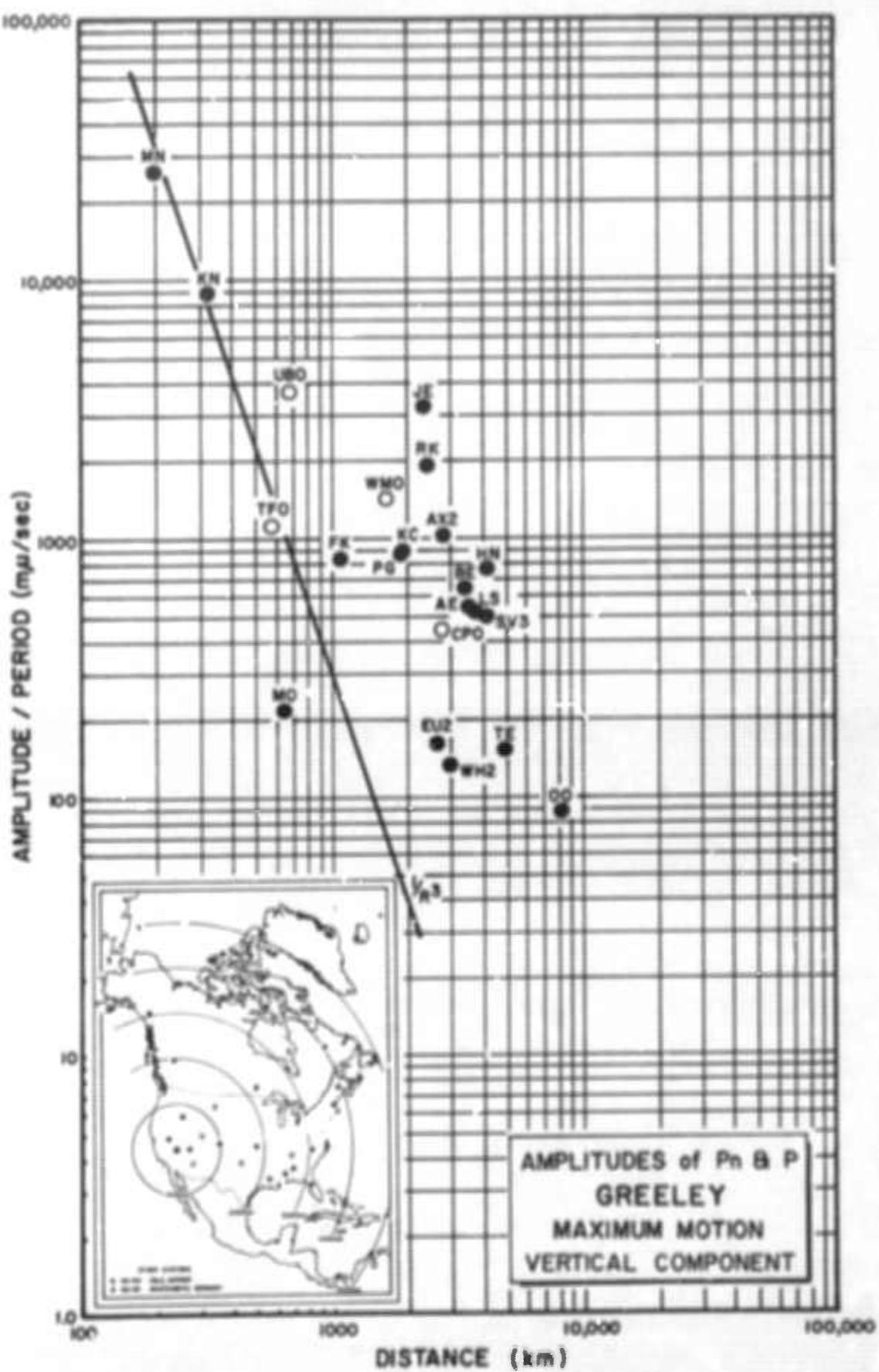


Figure 4



**Figure 5**

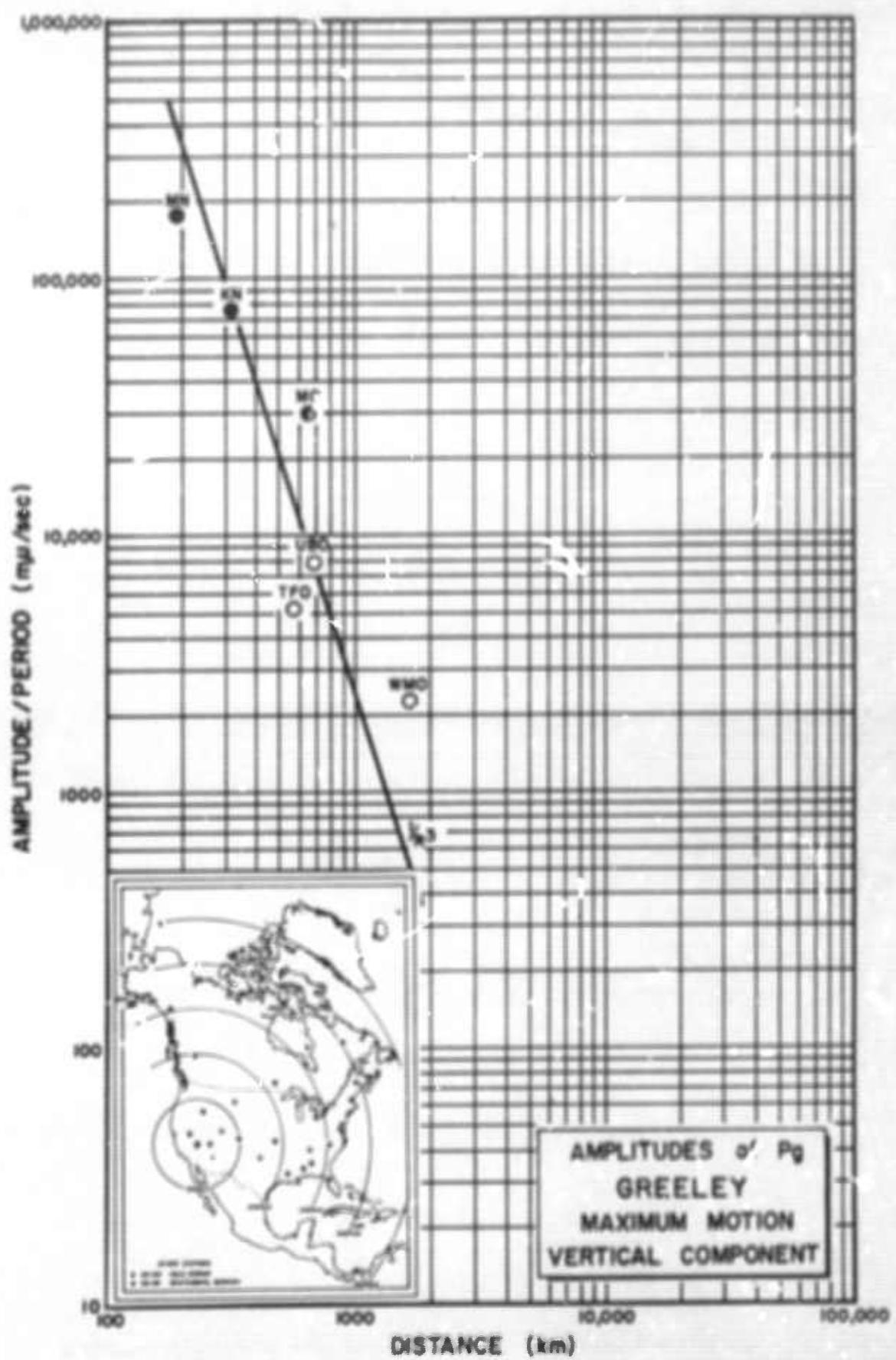


Figure 6

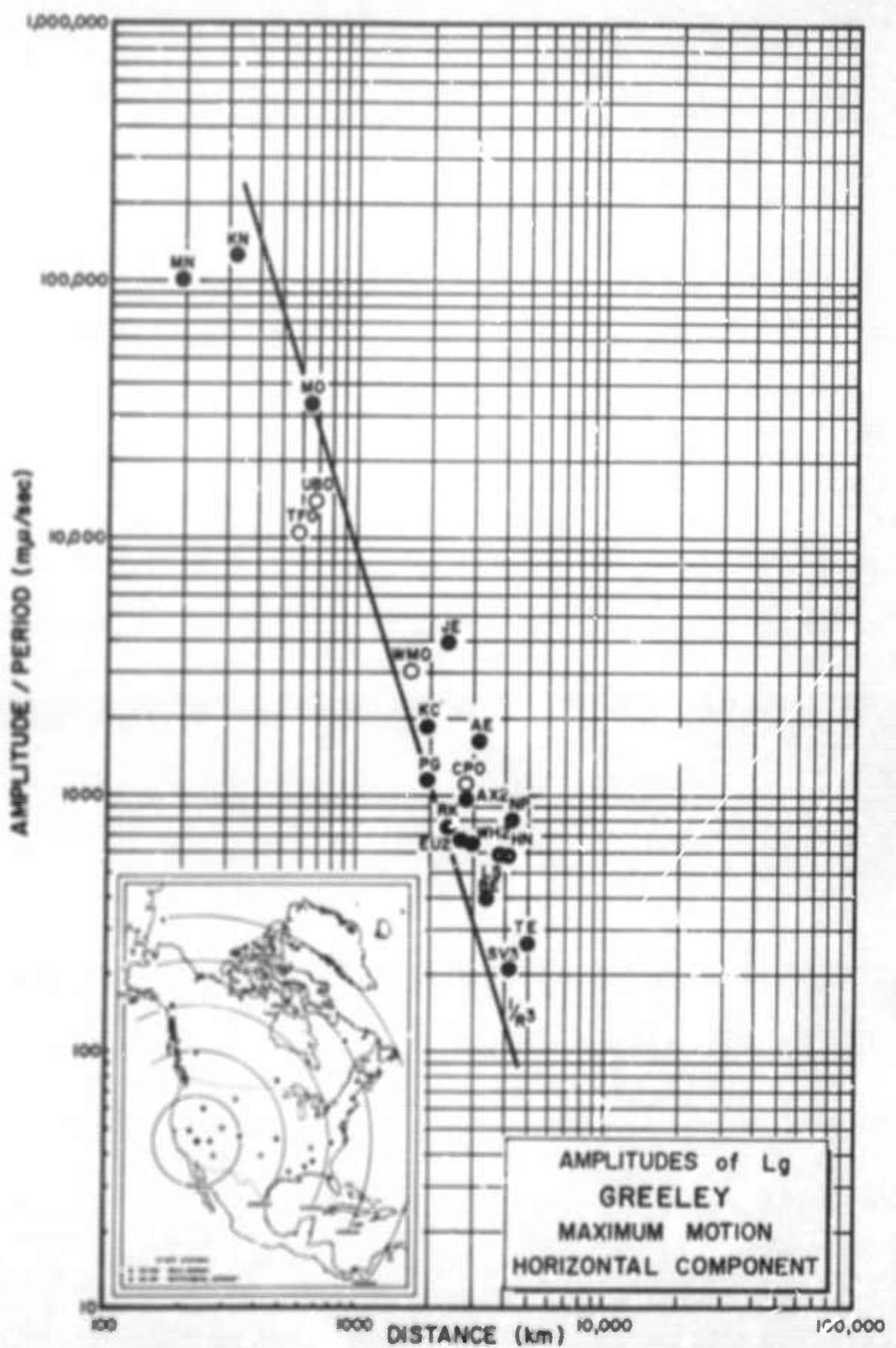


Figure 7

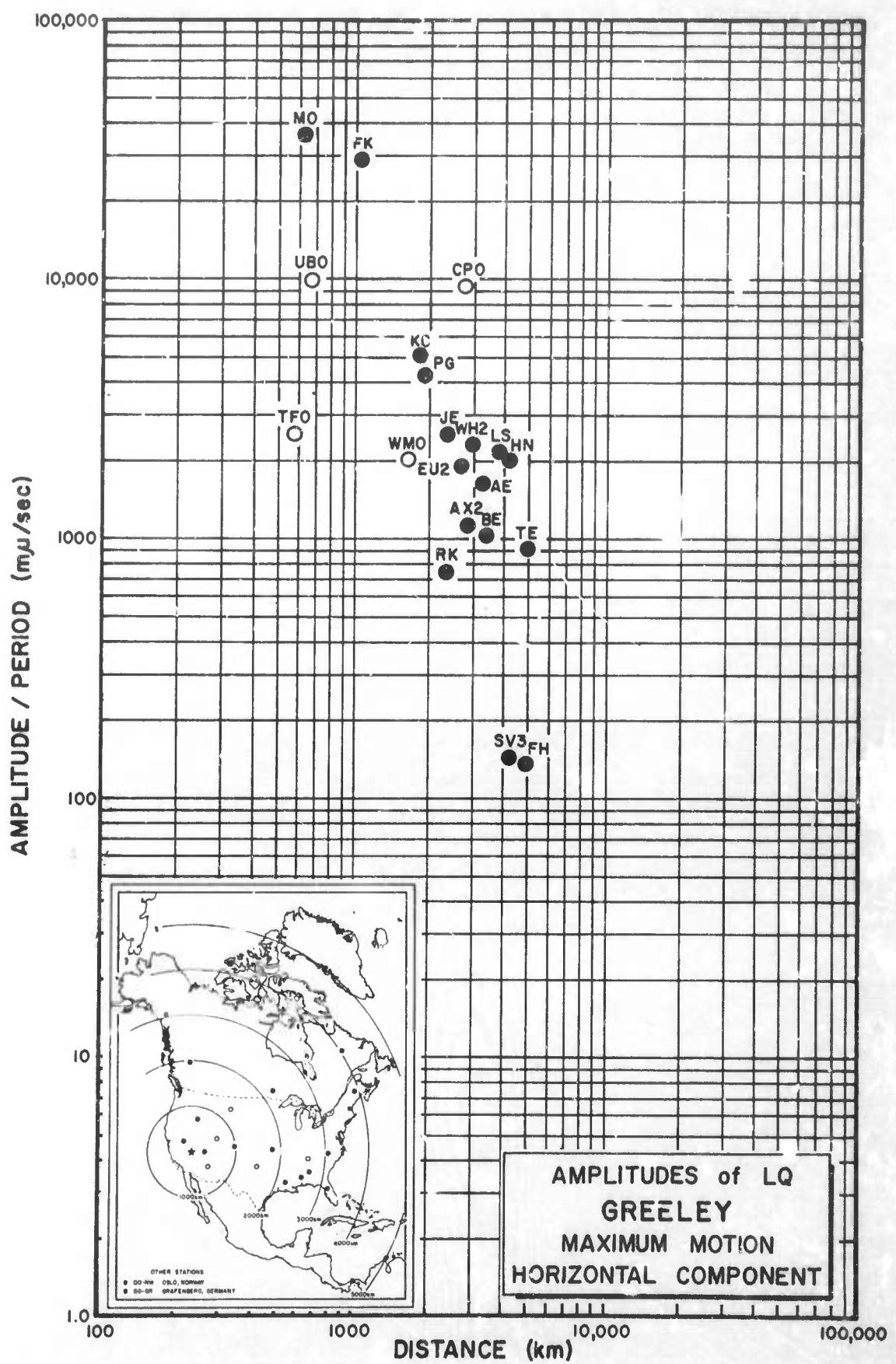


Figure 8

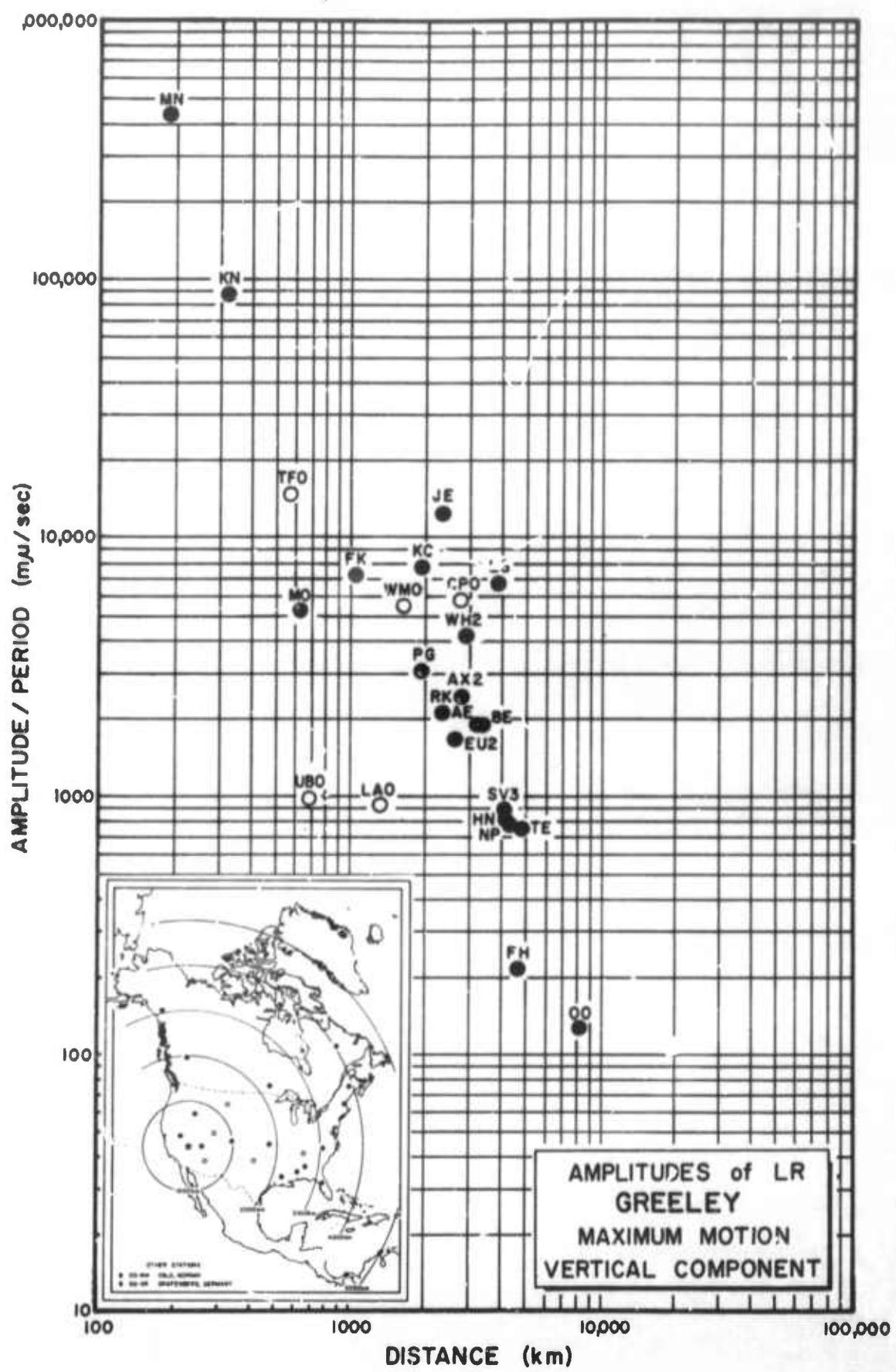


Figure 9

Appendix 1 (A)

Recording Site Information - Greeley

| Code      | Station                                      | Distance<br>(km) | Geographic<br>Latitude | Geographic<br>Longitude | Elev.<br>(m) | Computed Azimuth<br>Epi.<br>sta. | Installd. Azimuth<br>Sta.<br>Radial | Tang.<br>Radial | Range or<br>Shall<br>Sp. | Up<br>-East. |
|-----------|--|------------------|------------------------|-------------------------|--------------|----------------------------------|-------------------------------------|-----------------|--------------------------|--------------|
| NE-MER*   | Mesa, Nevada                                 | 190              | 38°26'10"E             | 116°08'53"E             | 1,52         | 120°                             | 208°                                | 030°            | L                        | X            |
| KS-UT*    | Kanab, Utah                                  | 320              | 37°01'22"N             | 112°49'39"E             | 1,74         | 94°                              | 277°                                | 95°             | 105°                     | L            |
| TENT-PER* | Tente Forest<br>Observatory, Arizona         | 572              | 34°17'13"N             | 111°16'03"E             | 1,49         | 124°                             | 307°                                | 90°             | 90°                      | X            |
| TPSO-250  | Mountain Home, Idaho                         | 541              | 43°04'19"W             | 116°15'56"W             | .79          | 01°                              | 181°                                | 255°            | 80°                      | L            |
| ND-ID*    | Ulute Basin<br>Observatory, Utah             | 693              | 40°19'18"W             | 109°34'07"W             | 1,60         | 58°                              | 243°                                | 90°             | 0°                       | X            |
| UNSO-210  | Franktown, Colorado                          | 1073             | 39°35'12"W             | 104°27'42"W             | 1,80         | 73°                              | 200°                                | 75°             | 105°                     | L            |
| FR-COP*   | Saberry Rd-10, Montana                       | 1,340            | 46°41'15"W             | 106°13'20"W             | .90          | 26°                              | 323°                                | 105°            | 105°                     | X            |
| ZAO       | Michite Mountain<br>Observatory, Oklahoma    | 1629             | 34°43'05"W             | 98°35'21"W              | .51          | 95°                              | 285°                                | 90°             | 0°                       | X            |
| WESO-25   | Kansas City, Missouri                        | 1910             | 39°21'31"W             | 94°40'17"W              | .27          | 76°                              | 370°                                | 135°            | 235°                     | L            |
| NC-MO     | Prince George, British<br>Columbia, Canada   | 1915             | 53°59'50"N             | 123°21'23"W             | .91          | 348°                             | 163°                                | 110°            | 200°                     | L            |
| PE-BC     | Jene, Louisiana                              | 2314             | 31°47'05"W             | 92°00'55"W              | .05          | 94°                              | 303°                                | 286°            | 316°                     | L            |
| SE-ON*    | Red Lake<br>Ontario, Canada                  | 2346             | 50°50'30"W             | 95°40'20"W              | .37          | 43°                              | 339°                                | 54°             | 140°                     | S            |
| EUDAL     | Butes, Alabama                               | 2639             | 32°42'47"W             | 87°53'05"W              | .04          | 92°                              | 289°                                | 41°             | 131°                     | S            |
| CPSO-29   | Cumberland Plateau<br>Observatory, Tennessee | 2759             | 35°38'41"W             | 85°34'13"W              | .57          | 85°                              | 283°                                | 60°             | 0°                       | X            |
| AR2AL     | Alexander City, Alabama                      | 2796             | 32°08'38"W             | 86°07'48"W              | .31          | 91°                              | 289°                                | 130°            | 320°                     | L            |
| WATTC*    | Whitehorse, Yukon<br>Territories, Canada     | 2913             | 60°41'41"W             | 124°39'03"W             | .85          | 339°                             | 145°                                | 325°            | 355°                     | L            |
| AB-MC*    | Albermarle, North Carolina                   | 3249             | 35°26'01"W             | 80°03'32"W              | .18          | 67°                              | 284°                                | 104°            | 194°                     | Goech        |
| BP-TL     | Belleview, Florida                           | 3318             | 35°34'19"W             | 83°31'32"W              | .79          | 96°                              | 295°                                | 140°            | 320°                     | S            |
| LS-NH*    | Lisbon, New Hampshire                        | 3788             | 44°14'16"W             | 71°55'21"W              | .29          | 64°                              | 274°                                | 96°             | 184°                     | Goech        |
| ME-KE*    | Bowles, Maine                                | 4082             | 46°09'43"W             | 67°59'09"W              | .21          | 60°                              | 374°                                | 95°             | 183°                     | S            |
| SV-308    | Schefferville, Quebec,<br>Canada             | 4193             | 54°46'39"W             | 66°45'00"W              | .58          | 46°                              | 263°                                | 139°            | 320°                     | S            |
| BP-S7*    | Mould Bay, Northwest<br>Territories, Canada  | 4344             | 76°15'00"W             | 116°52'18"W             | .06          | 359°                             | 176°                                | 256°            | 342°                     | X            |
| PR-PB*    | Fort Sherman, Panama                         | 4789             | 09°21'47"W             | 79°57'30"W              | .03          | 121°                             | 316°                                | 121°            | 347°                     | Goech        |
| TE-GL*    | Thule, Greenland                             | 4956             | 76°29'30"W             | 68°34'10"W              | .21          | 14°                              | 237°                                | 57°             | 147°                     | Goech        |
| CO-NO*    | Gale, Norway                                 | 8120             | 61°02'53"W             | 10°51'42"E              | .56          | 34°                              | 318°                                | 130°            | 220°                     | L            |
| OC-GR*    | Grafenberg, Germany                          | 9095             | 49°41'32"W             | 11°11'55"E              | .53          | 21°                              | 320°                                | 140°            | 220°                     | L            |

\* Seismometers Oriented Toward Nevada Test site

Unified Magnitude:  $m = \log_{10} (A/T) + B$

where

A = zero to peak ground motion in millimicrons  
 $= \frac{\text{mm}}{1000}$

K

T = signal period in seconds

B = distance factor (see Table below)

mm = record amplitude in millimeters zero to peak

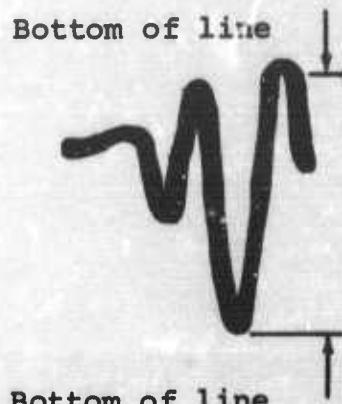
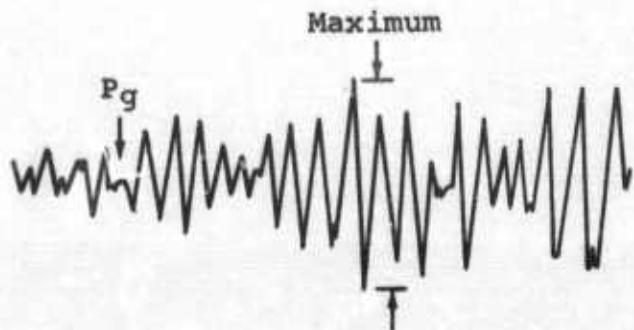
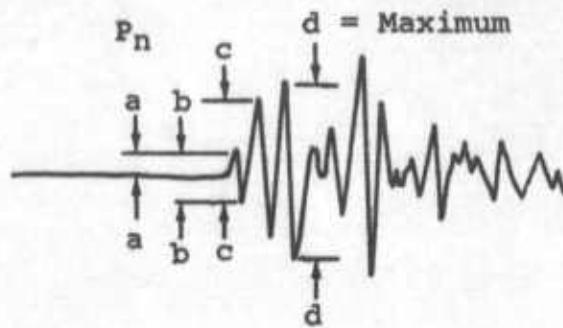
K = magnification in thousands at signal frequency

Table of Distance Factors (B) for Zero Depth

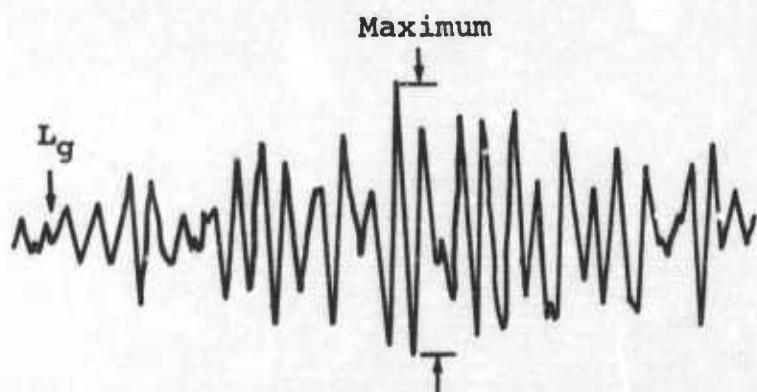
| Dist<br>(deg) | B   | Dist<br>(deg) | B   | Dist<br>(deg) | B   | Dist<br>(deg) | B   |
|---------------|-----|---------------|-----|---------------|-----|---------------|-----|
| 0°            | -   | 27°           | 3.5 | 54°           | 3.8 | 80°           | 3.7 |
| 1             | -   | 28            | 3.6 | 55            | 3.8 | 81            | 3.8 |
| 2             | 2.2 | 29            | 3.6 | 56            | 3.8 | 82            | 3.9 |
| 3             | 2.7 | 30            | 3.6 | 57            | 3.8 | 83            | 4.0 |
| 4             | 3.1 | 31            | 3.7 | 58            | 3.8 | 84            | 4.0 |
| 5             | 3.4 | 32            | 3.7 | 59            | 3.8 | 85            | 4.0 |
| 6             | 3.6 | 33            | 3.7 | 60            | 3.8 | 86            | 3.9 |
| 7             | 3.8 | 34            | 3.7 | 61            | 3.9 | 87            | 4.0 |
| 8             | 4.0 | 35            | 3.7 | 62            | 4.0 | 88            | 4.1 |
| 9             | 4.2 | 36            | 3.6 | 63            | 3.9 | 89            | 4.0 |
| 10            | 4.3 | 37            | 3.5 | 64            | 4.0 | 90            | 4.0 |
| 11            | 4.2 | 38            | 3.5 | 65            | 4.0 | 91            | 4.1 |
| 12            | 4.1 | 39            | 3.4 | 66            | 4.0 | 92            | 4.1 |
| 13            | 4.0 | 40            | 3.4 | 67            | 4.0 | 93            | 4.2 |
| 14            | 3.6 | 41            | 3.5 | 68            | 4.0 | 94            | 4.1 |
| 15            | 3.3 | 42            | 3.5 | 69            | 4.0 | 95            | 4.2 |
| 16            | 2.9 | 43            | 3.5 | 70            | 3.9 | 96            | 4.3 |
| 17            | 2.9 | 44            | 3.5 | 71            | 3.9 | 97            | 4.4 |
| 18            | 2.9 | 45            | 3.7 | 72            | 3.9 | 98            | 4.5 |
| 19            | 3.0 | 46            | 3.8 | 73            | 3.9 | 99            | 4.5 |
| 20            | 3.0 | 47            | 3.9 | 74            | 3.8 | 100           | 4.4 |
| 21            | 3.1 | 48            | 3.9 | 75            | 3.8 | 101           | 4.3 |
| 22            | 3.2 | 49            | 3.8 | 76            | 3.9 | 102           | 4.4 |
| 23            | 3.3 | 50            | 3.7 | 77            | 3.9 | 103           | 4.5 |
| 24            | 3.3 | 51            | 3.7 | 78            | 3.9 | 104           | 4.6 |
| 25            | 3.5 | 52            | 3.7 | 79            | 3.8 | 105           | 4.7 |
| 26            | 3.4 | 53            | 3.7 |               |     |               |     |

Unified Magnitudes From P<sub>n</sub> or P Waves

Appendix I(B)



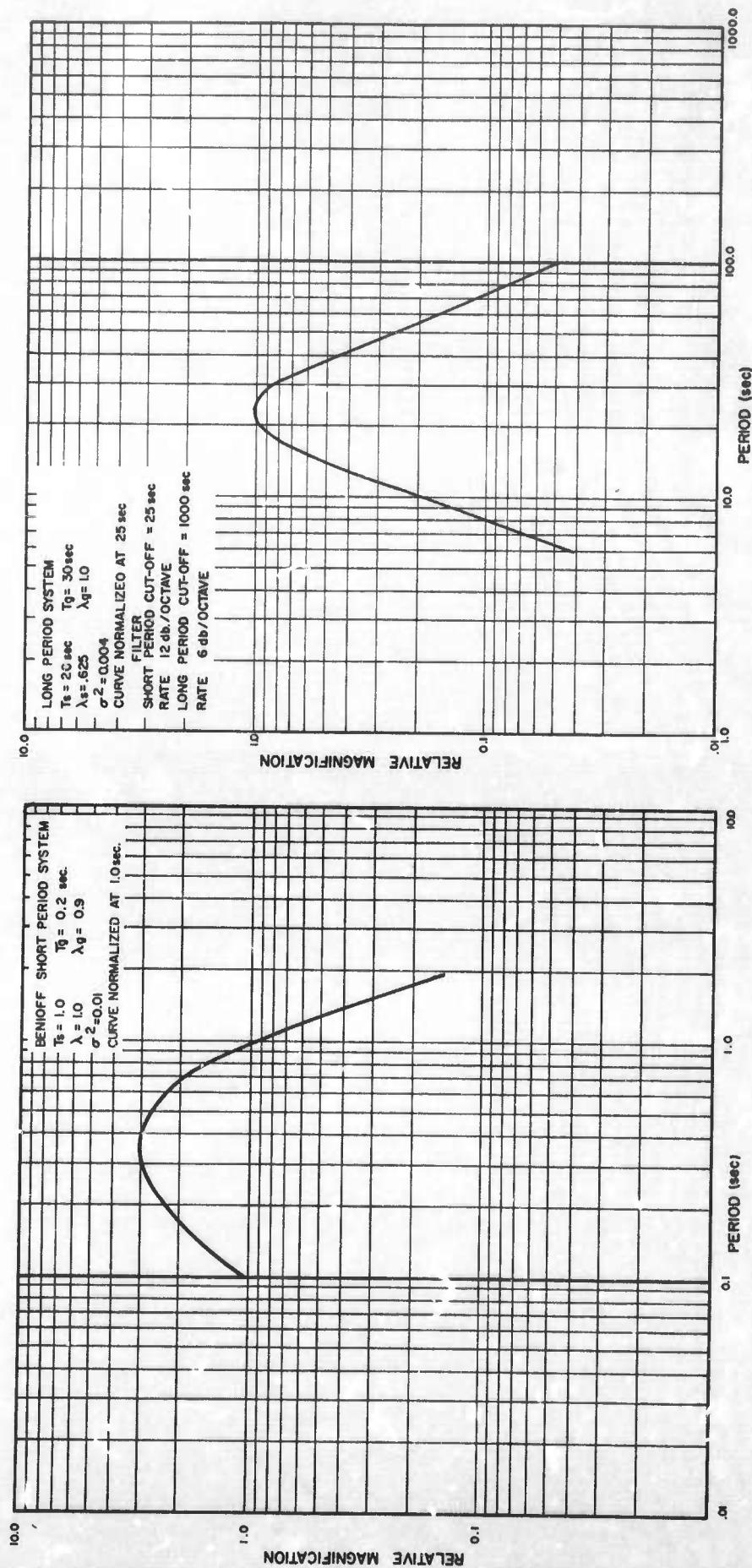
Detail Showing Allowance  
For Line Width



Pick time of  $P_n$  at beginning of "a" half cycle.

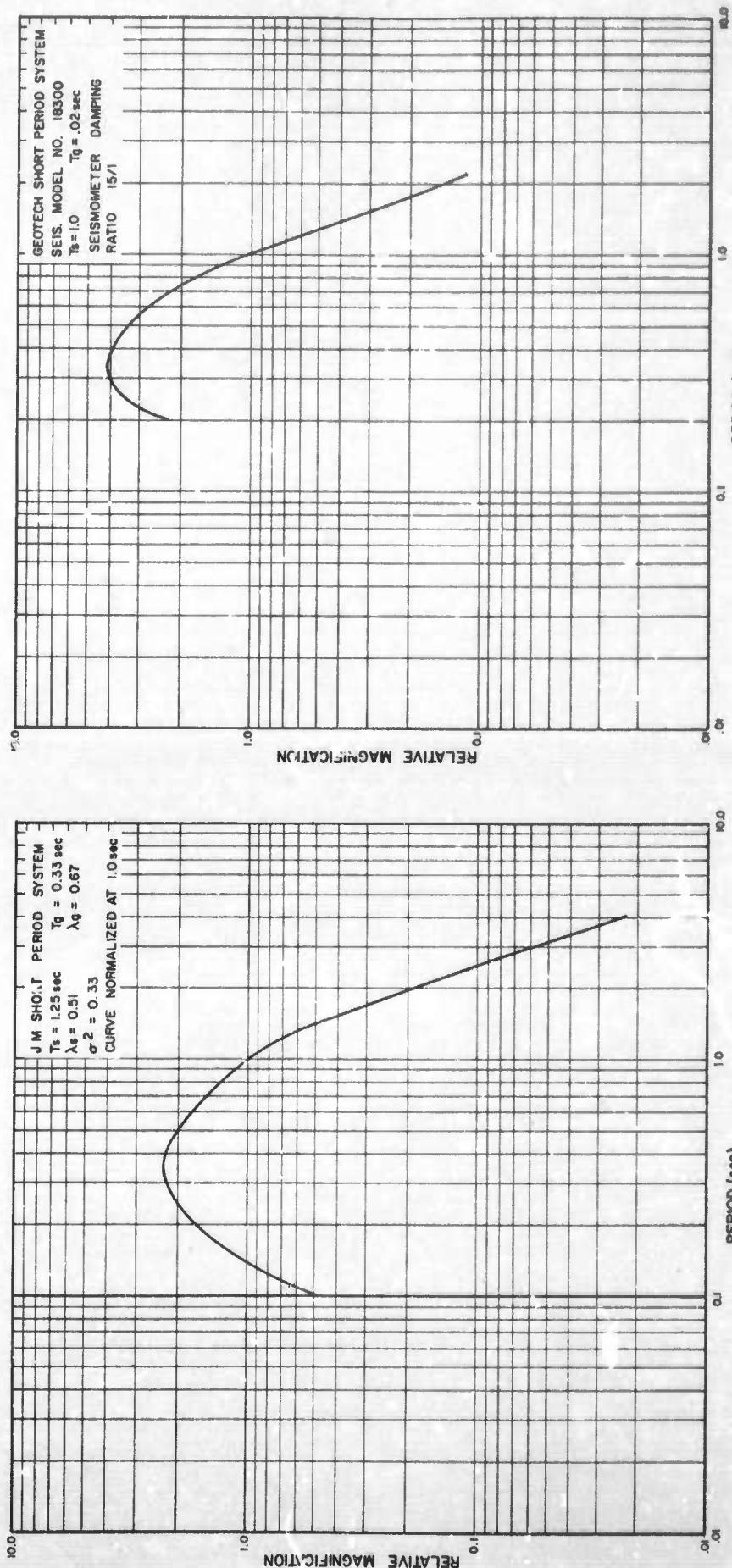
Pick amplitude of  $P_n$  as maximum " $d/2$ " within 2 or 3 cycles of "c".

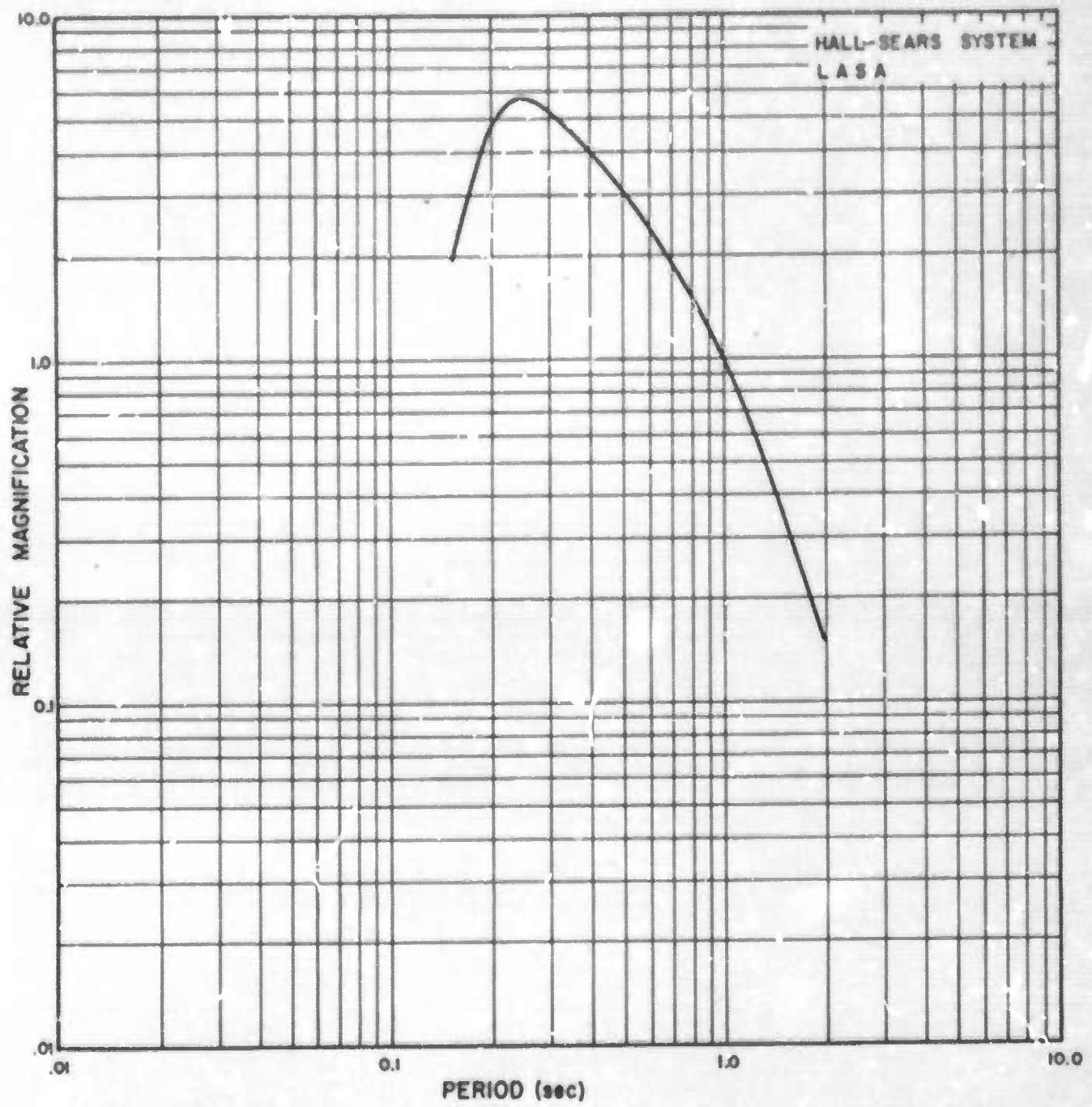
Pick amplitudes of  $P_g$  and  $L_g$  at maximum of corresponding motion.



APPENDIX II (C)

INSTRUMENT RESPONSE CURVES - OTHER SHCRT PERIOD





INSTRUMENT RESPONSE CURVE - LASA

Unclassified

Security Classification

DOCUMENT CONTROL DATA - RAD

(Security classification of this body of abstract and indexing information must be entered when the overall report is classified)

|   |  |  |                |
|---|--|--|----------------|
| 1. ORIGINATOR'S ACTIVITY (Congressional author)   |  | 2. REPORT SECURITY CLASSIFICATION  |                |
| TELEDYNE, INC.<br>ALEXANDRIA, VIRGINIA  |  | Unclassified / Acd   |                |
| 3. GROUP  |  |  |                |
| 4. REPORT TITLE   |  |  |                |
| LONG RANGE SEISMIC MEASUREMENTS - GREELEY   |  |  |                |
| 5. DESCRIPTIVE NOTES (Type of report and inclusive dates)   |  |  |                |
| Scientific  |  |  |                |
| 6. AUTHOR(S) (Last name, first name, middle initial)  |  |  |                |
| Clark, Don M.   |  |  |                |
| 7. REPORT DATE<br>28 APRIL 1967   |  | 8. TOTAL NO. OF PAGES<br>2   | 9. NO. OF REPS |
| 10. CONTRACT OR GRANT NO.<br>P 33657-67-C-1313  |  | 11. ORIGINATOR'S REPORT NUMBER(S)<br>SDL Report No. 180  |                |
| 12. PROJECT NO.<br>VELA T/6702  |  | 13. OTHER REPORT NO(S) (Any other numbers that may be assigned<br><i>(to report)</i> )<br>---                              |                |
| 14. ARPA Order No. 624  |  | 15. SPONSORING MILITARY ACTIVITY<br>ADVANCED RESEARCH PROJECTS AGENCY<br>NUCLEAR TEST DETECTION OFFICE<br>WASHINGTON, D.C. |                |
| 16. ARPA Program Code No. 5810  |  |  |                |
| 17. AVAILABILITY/LIMITATION NOTICES<br>This document is subject to special export controls and each transmittal to foreign governments or foreign national may be made only with prior approval of Chief, AFTAC.  |  |  |                |
| 18. SUPPLEMENTARY NOTES<br>---  |  | 19. ABSTRACT   |                |
| <p>An analysis of seismological data from an underground nuclear explosion as a continuing study to provide information to aid in distinguishing between earthquakes and explosion. A table of travel-times and amplitudes of P, Pg, Lg, and surface waves are included along with other unidentified phases.</p> |  |  |                |

DD FORM 1 JAN 68 1473

Unclassified

Security Classification

**Unclassified**

Security Classification

| 10<br>KEY WORDS     | LINK A |    | LINK B |    | LINK C |    |
|---------------------|--------|----|--------|----|--------|----|
|                     | ROLE   | WT | ROLE   | WT | ROLE   | WT |
| Sismic Magnitude    |        |    |        |    |        |    |
| Seismic Travel-Time |        |    |        |    |        |    |
| Seismic Amplitude   |        |    |        |    |        |    |
| VELA-UNIFONK        |        |    |        |    |        |    |
| Nuclear Tests       |        |    |        |    |        |    |

**INSTRUCTIONS**

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (corporate author) issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parentheses immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7e. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system number, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers (either by the originator or by the sponsor), also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification using standard statements such as:

- (1) "Qualified requesters may obtain copies of this report from DDC."
- (2) "Foreign announcement and dissemination of this report by DDC is not authorized."
- (3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through ."
- (4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through ."
- (5) "All distribution of this report is controlled. Qualified DDC users shall request through ."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring (paying for) the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

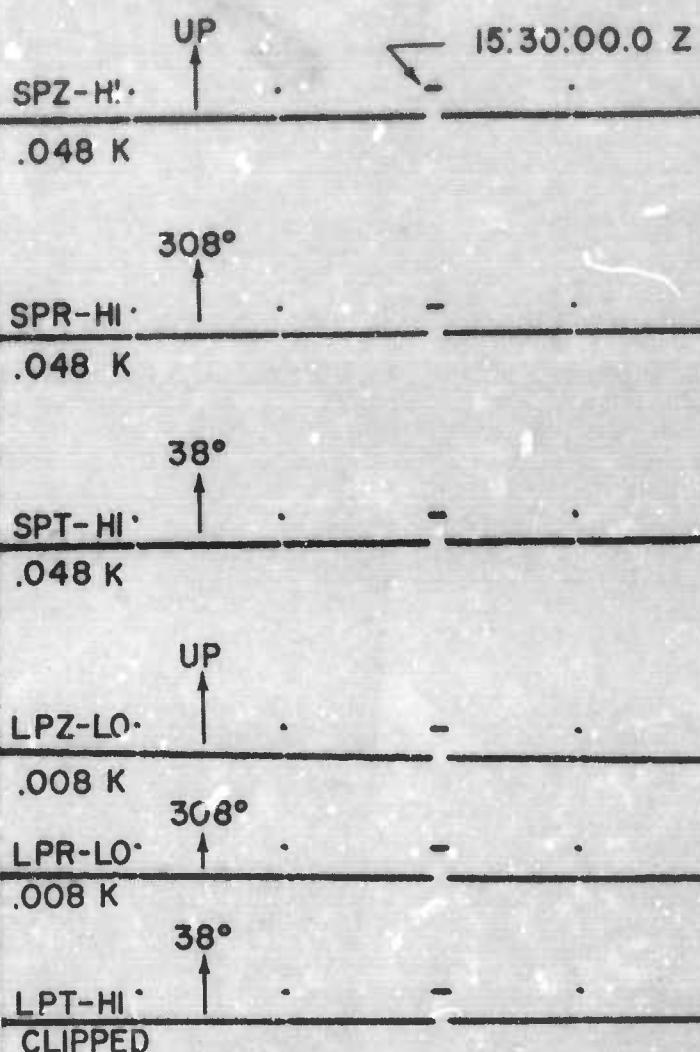
**GREELEY**

**MN - NV**

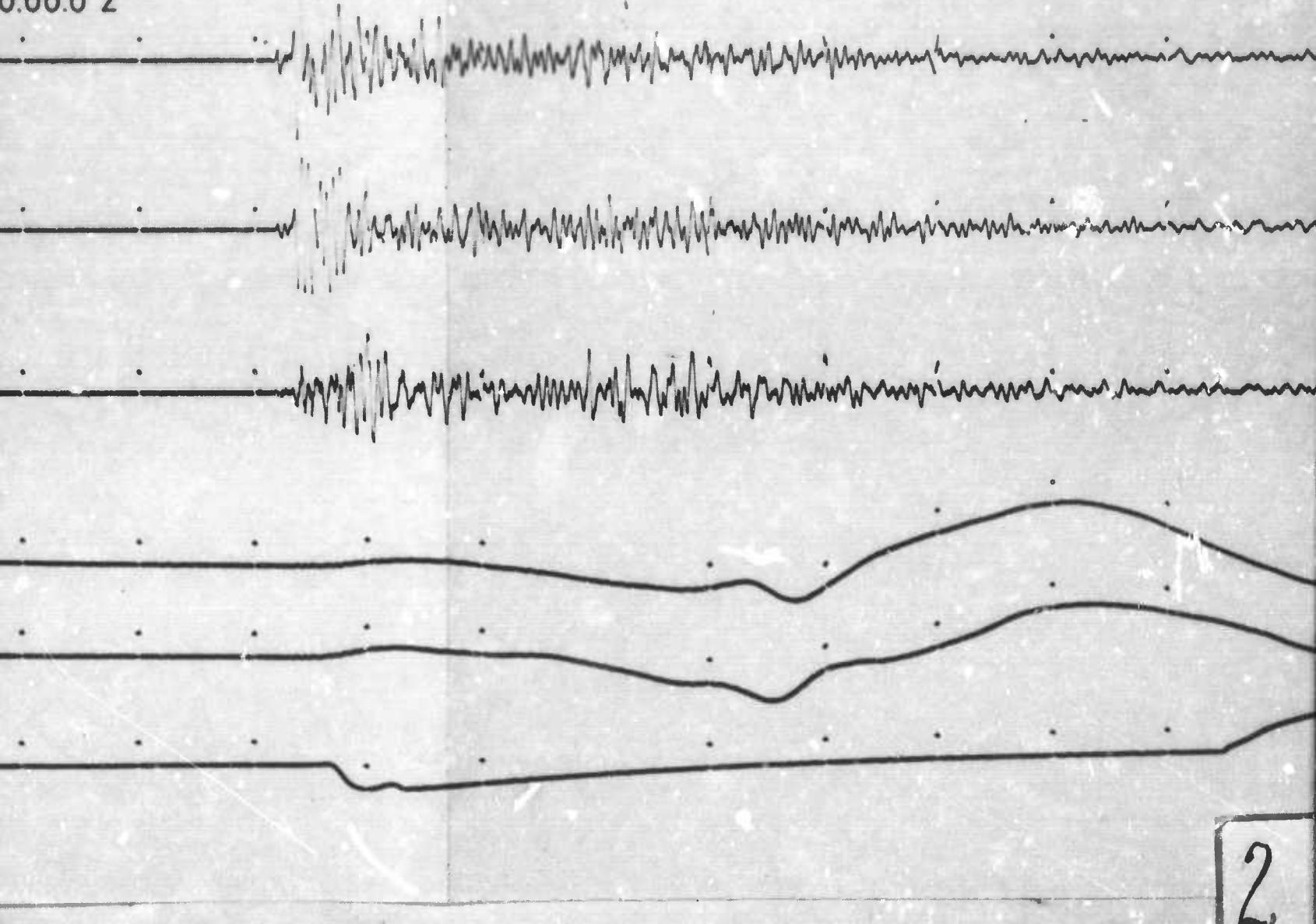
**MINA, NEVADA**

**20 DECEMBER 1966**

**$\Delta = 198 \text{ km}$**



0:00.0 Z



2

3

4

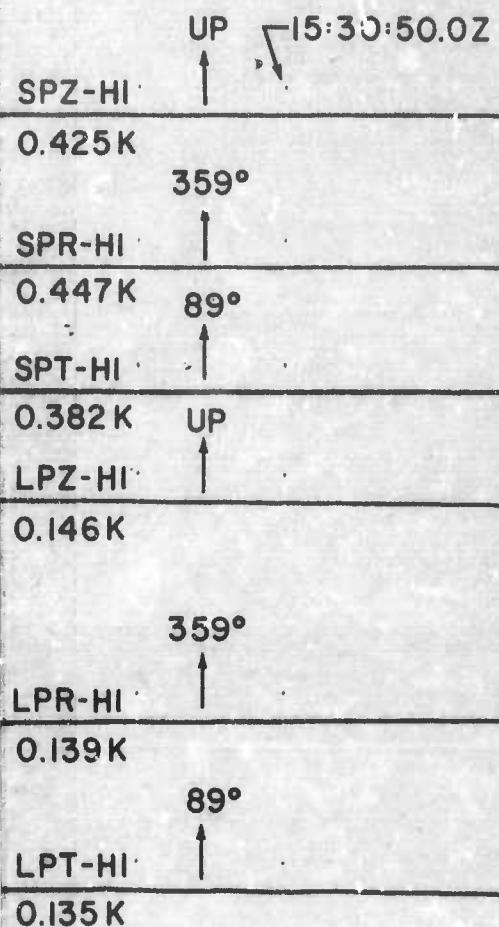
**GREELEY**

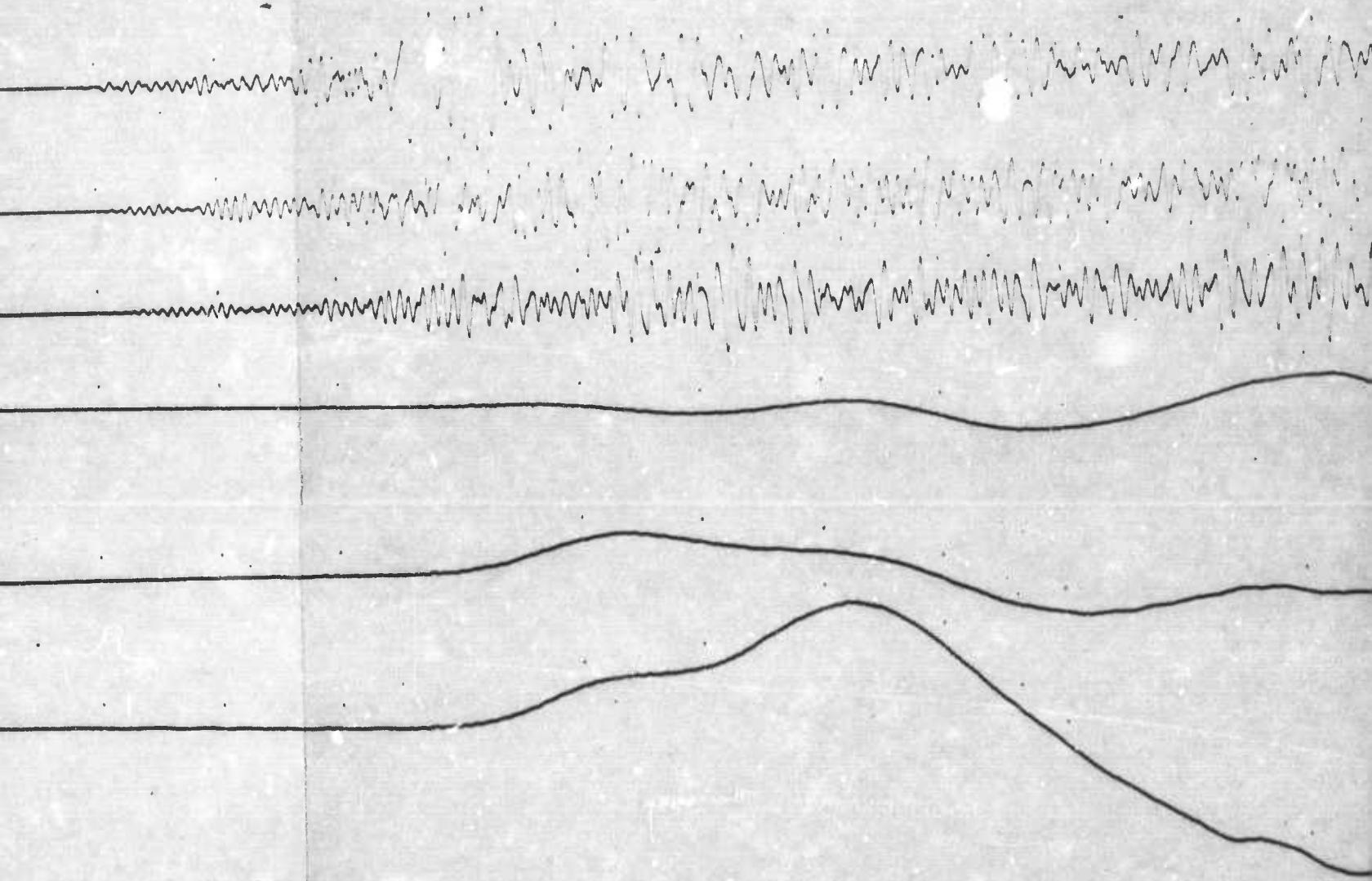
**MO-ID**

**MOUNTAIN HOME, IDAHO**

**20 DECEMBER 1966**

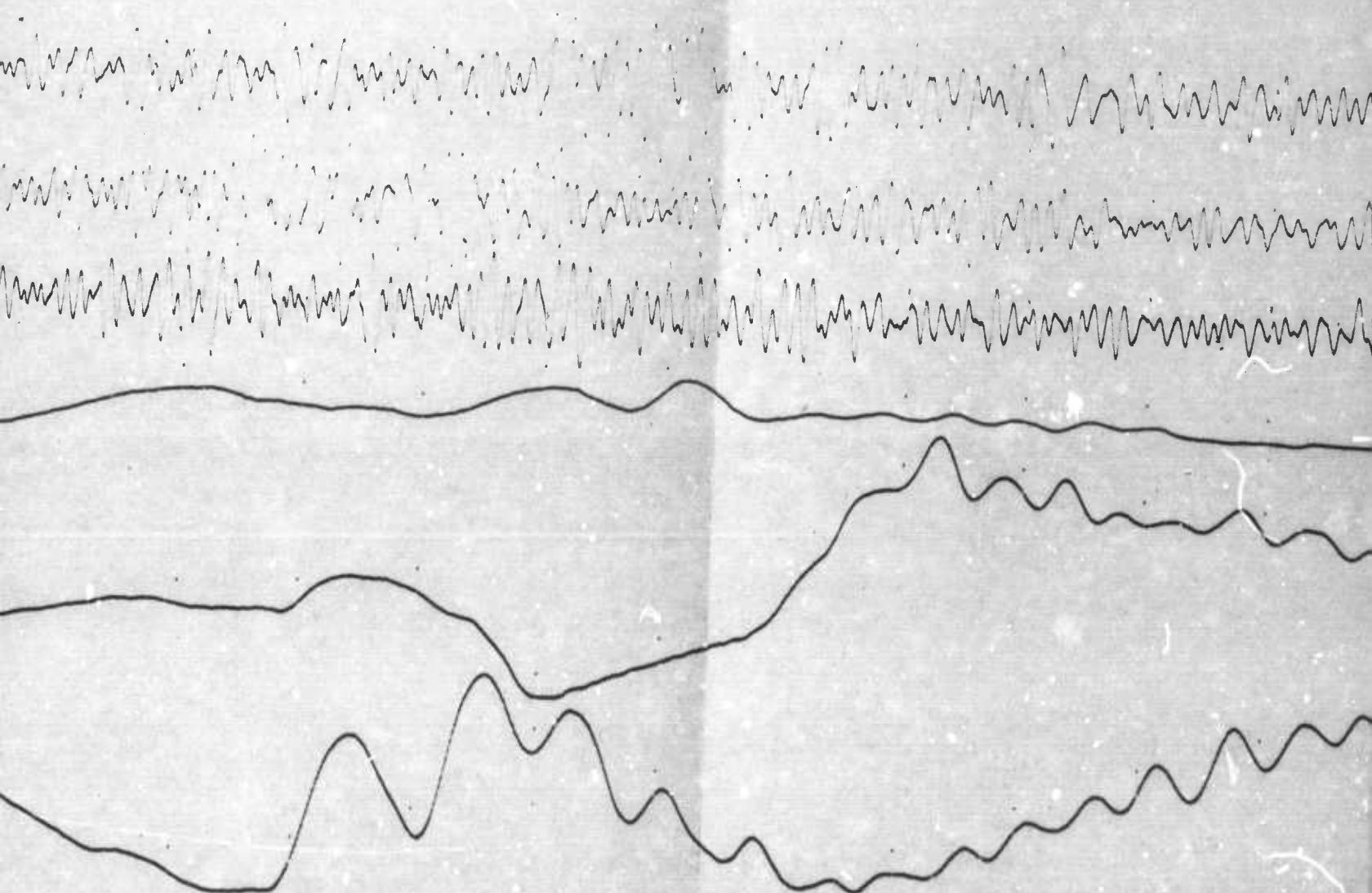
**$\Delta = 641 \text{ km.}$**

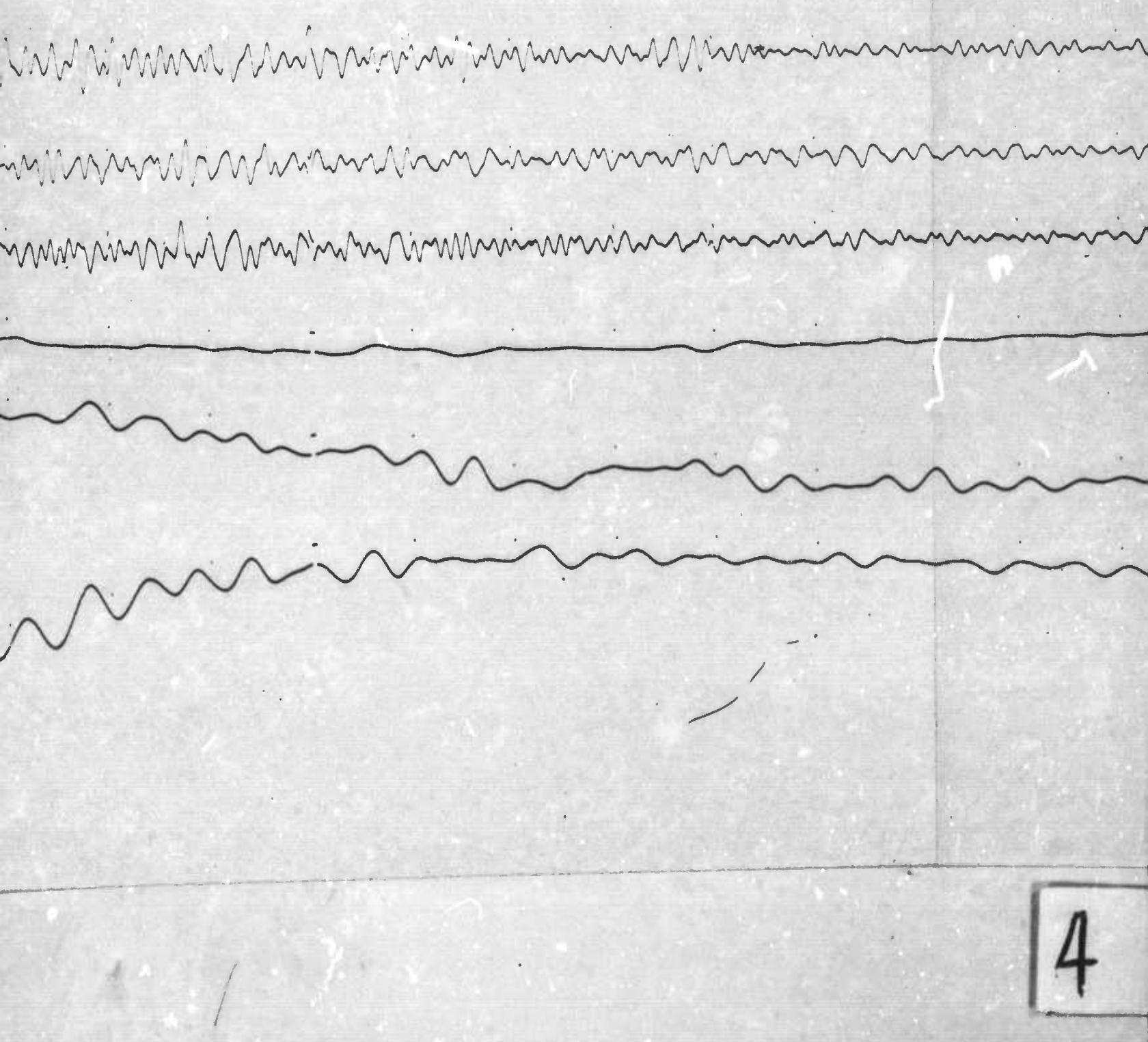




1

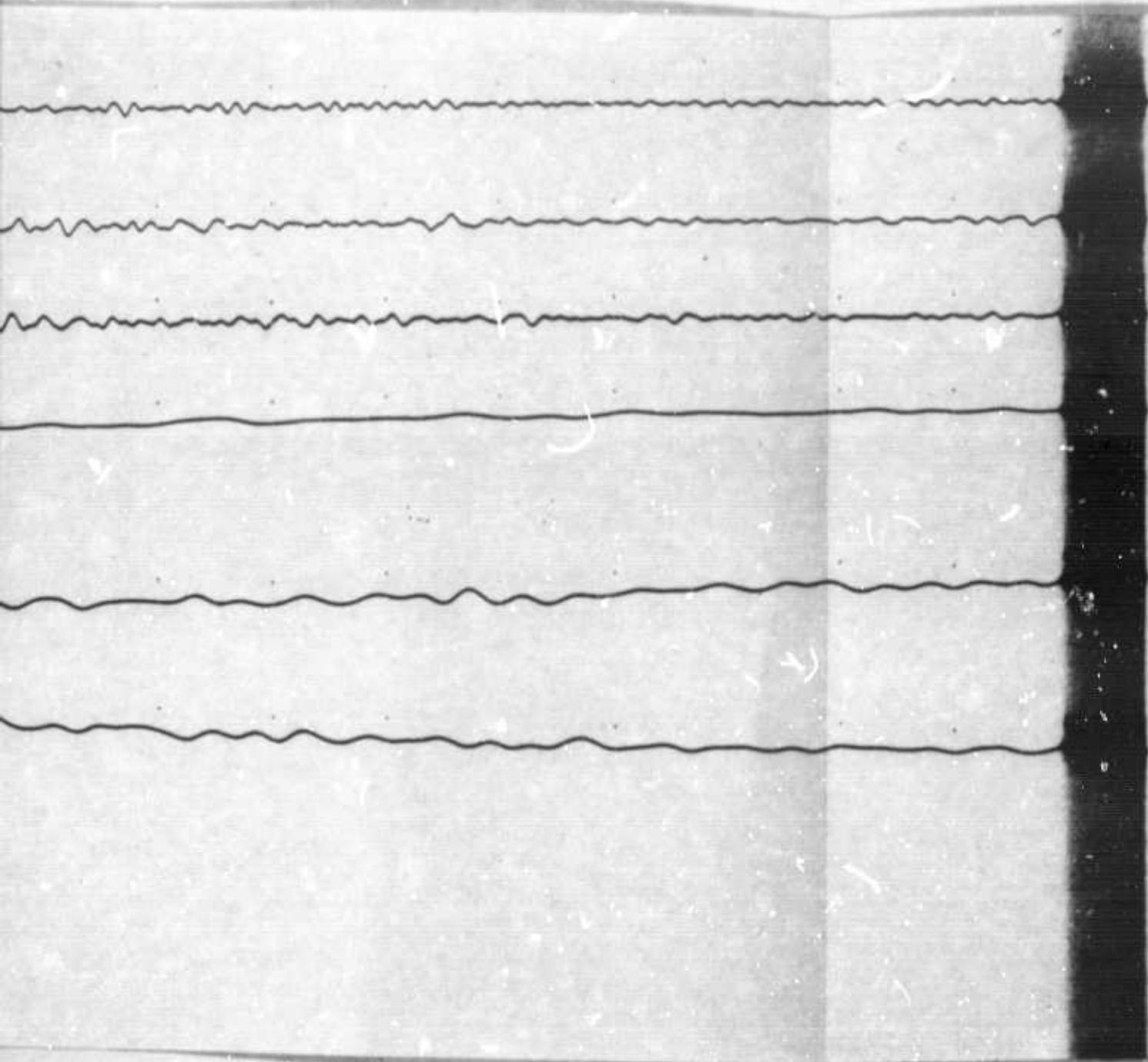
2







1



6

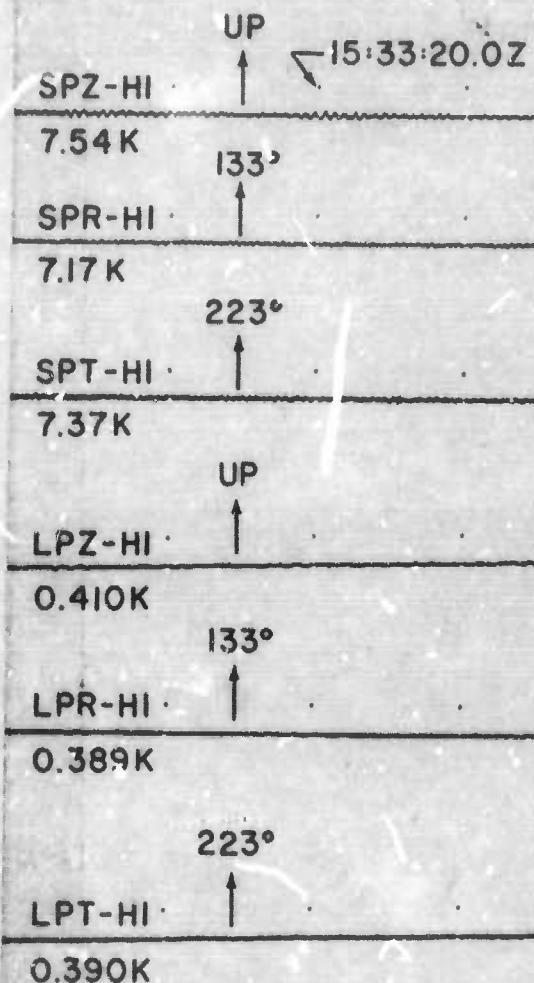
**GREELEY**

**KC-MO**

**KANSAS CITY, MISSOURI**

**20 DECEMBER 1966**

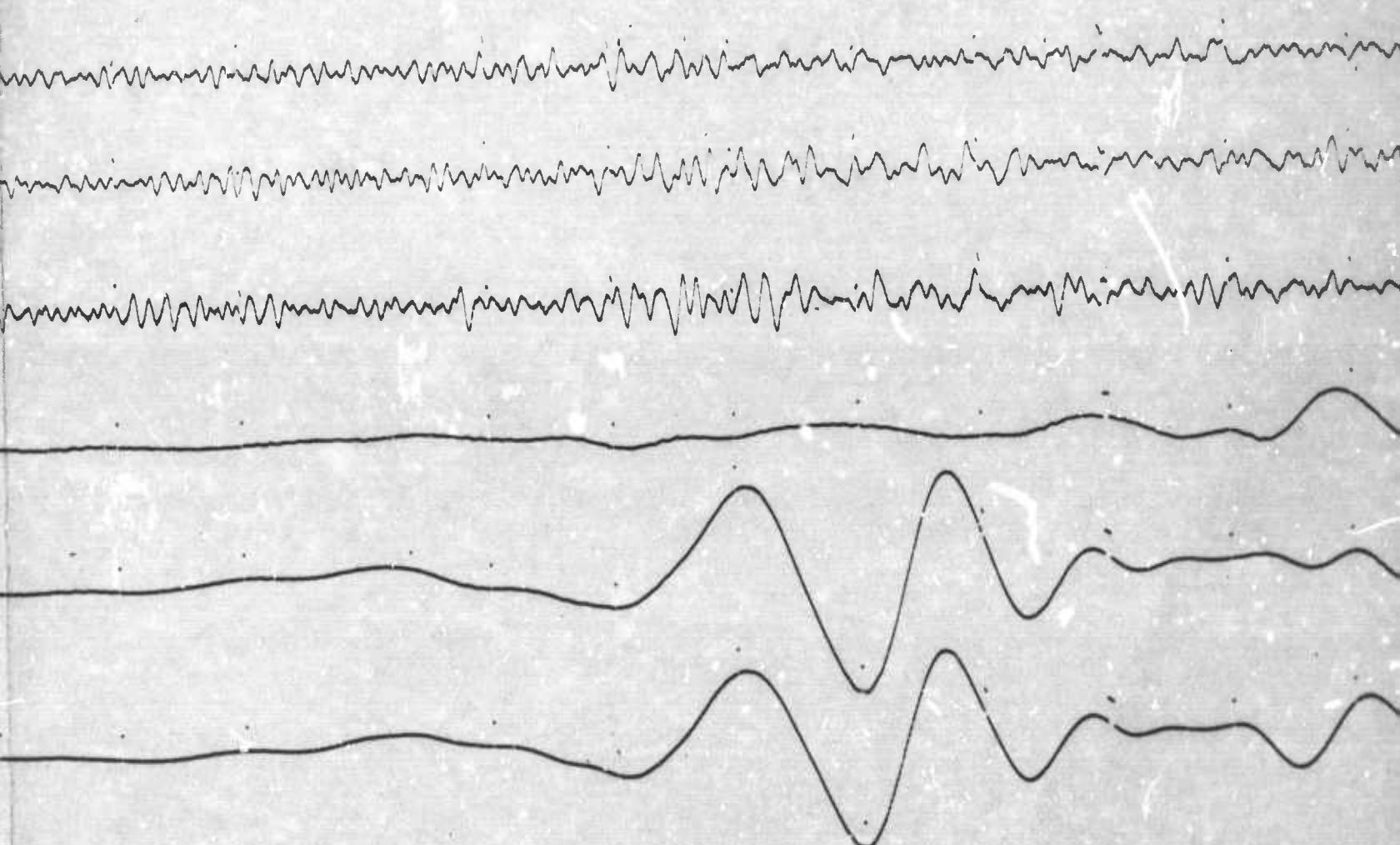
**$\Delta = 1910 \text{ km.}$**



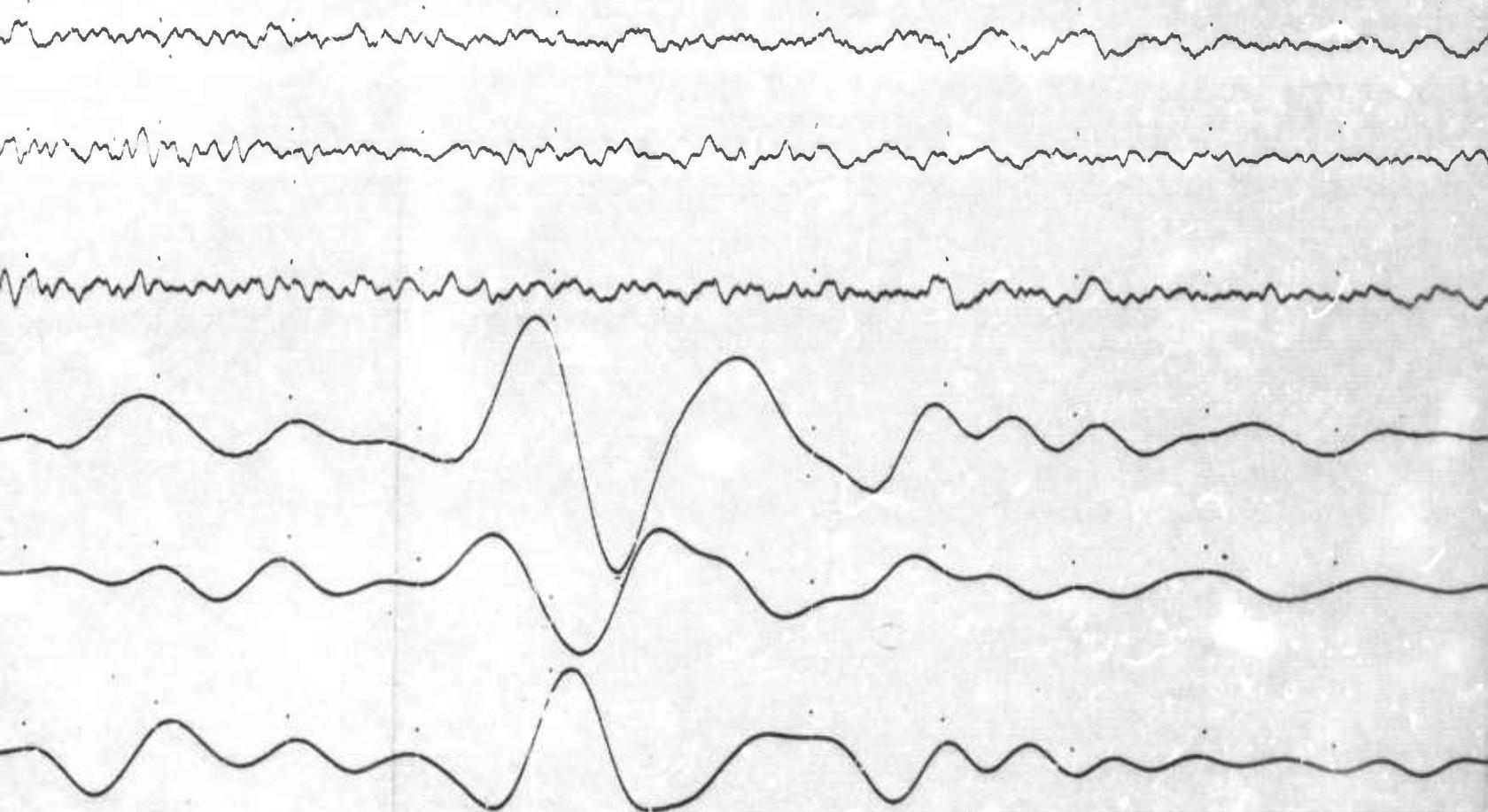
2

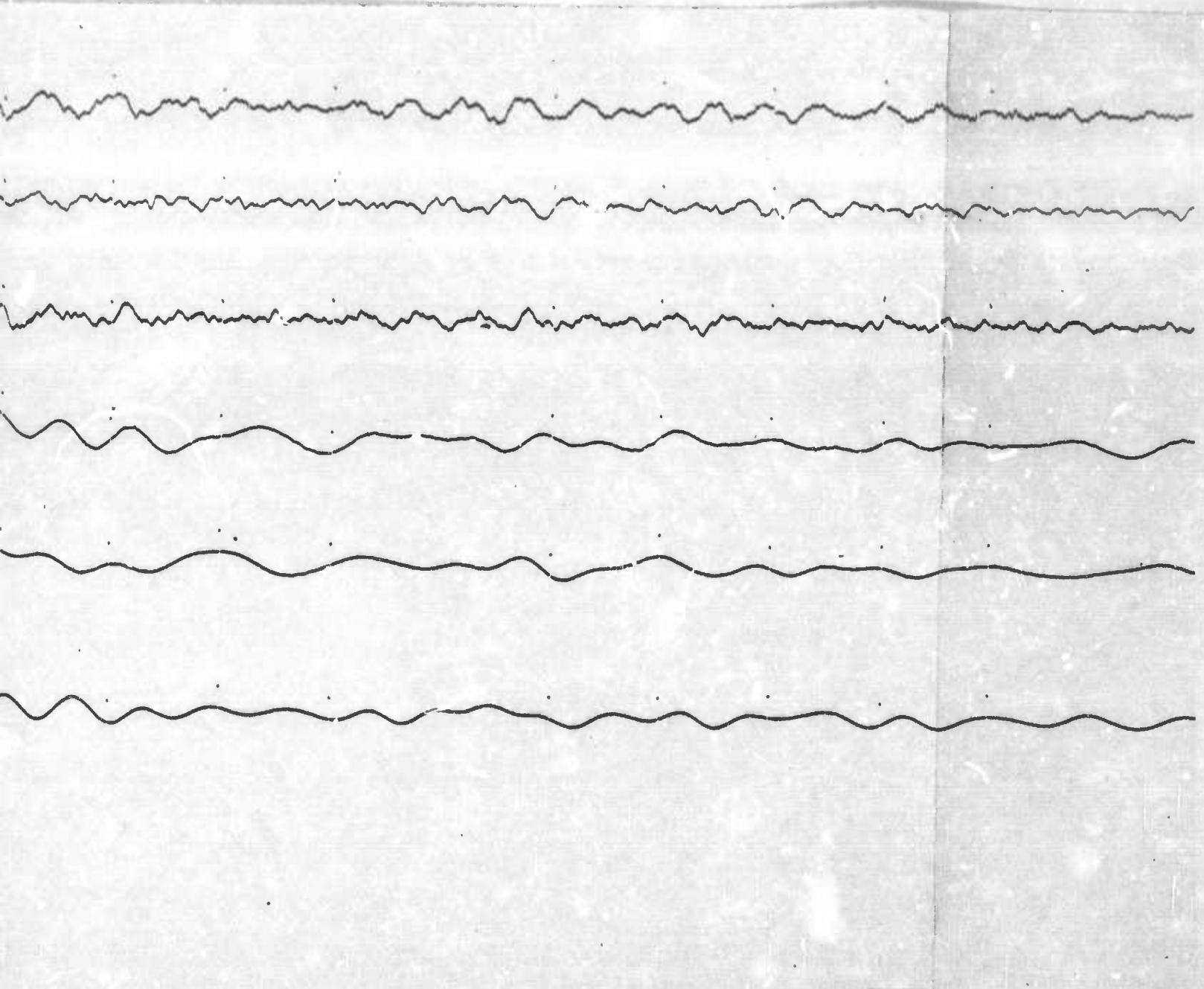
3

4



5





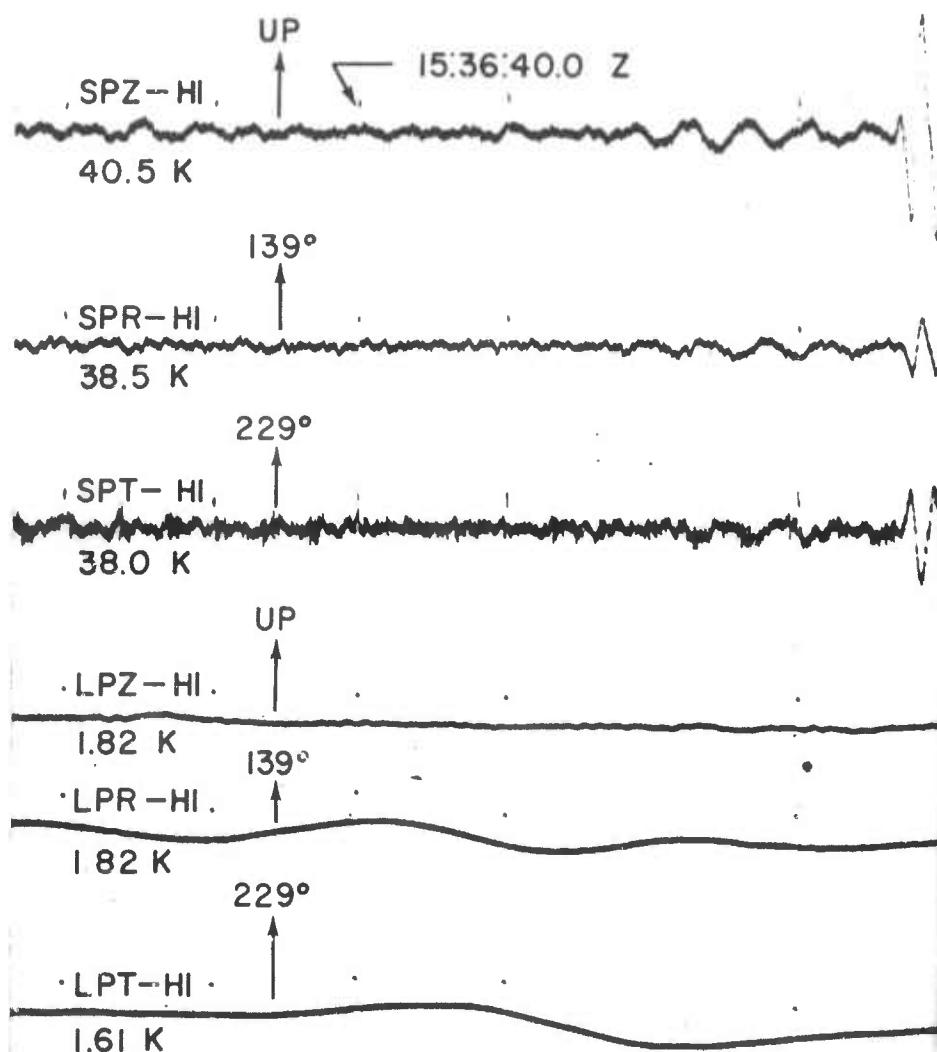
**GREELEY**

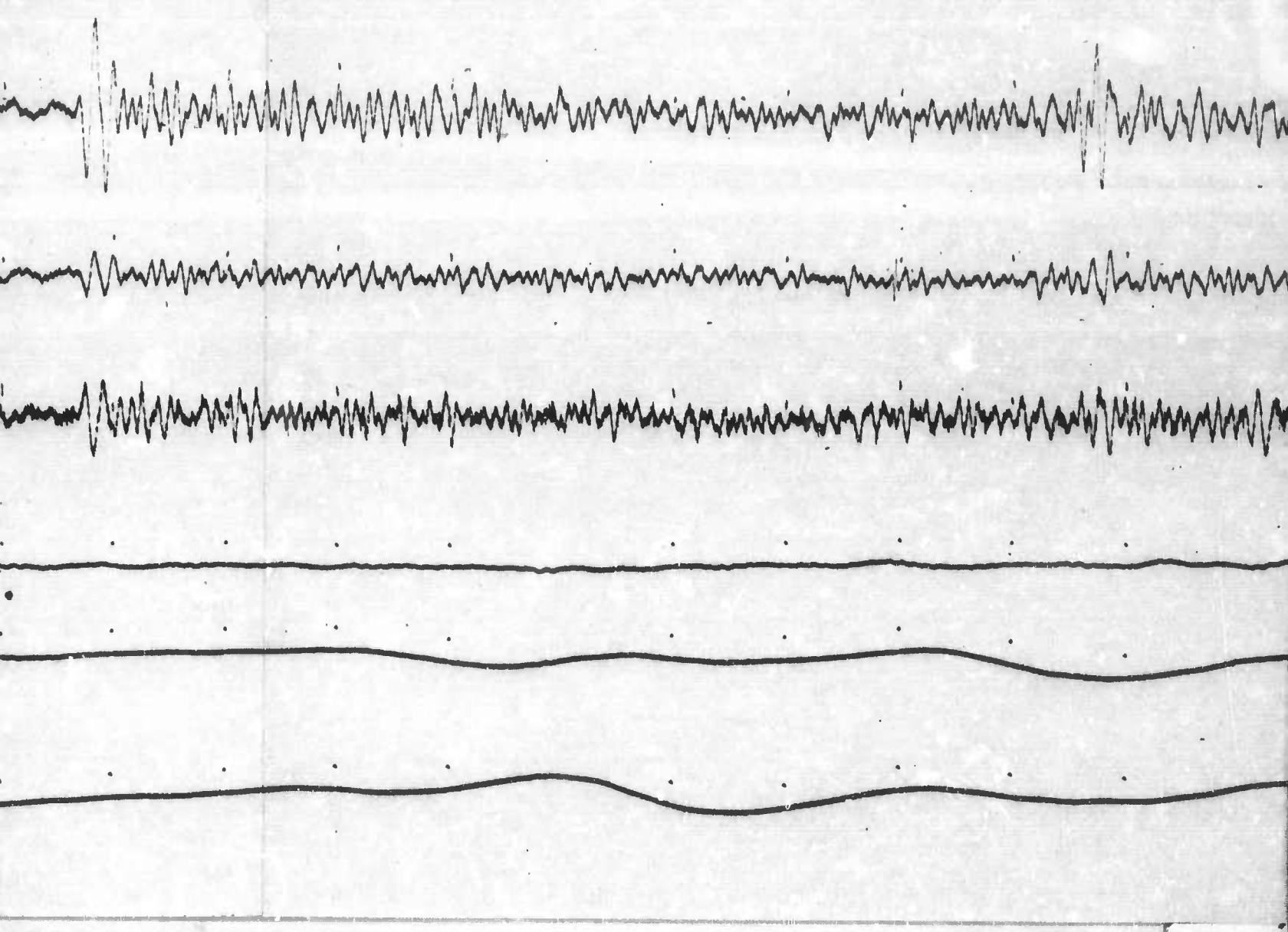
**SV3QB**

**SCHIEFFERVILLE, QUEBEC**

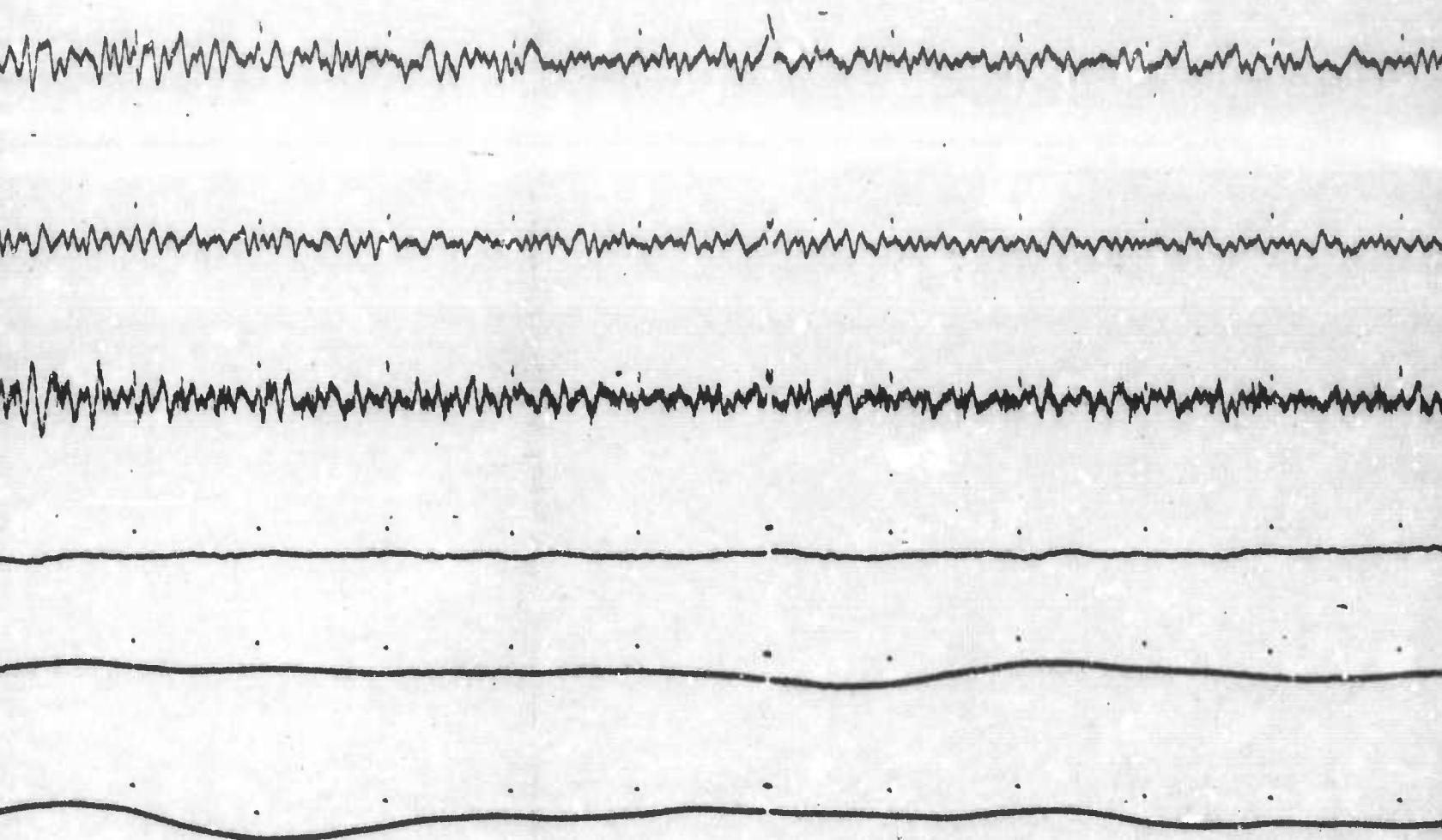
**20 DECEMBER 1966**

**$\Delta = 4195 \text{ km}$**

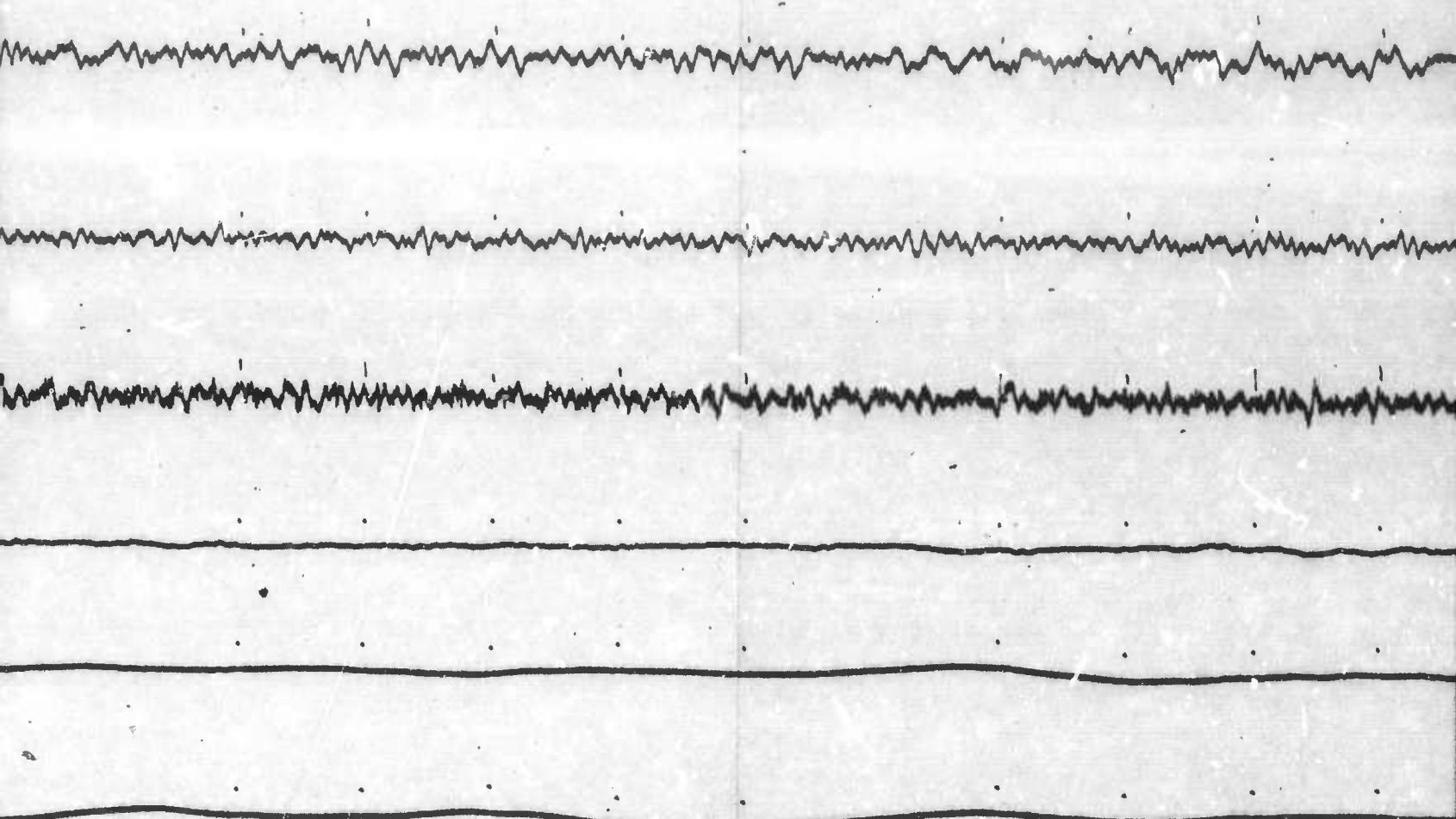




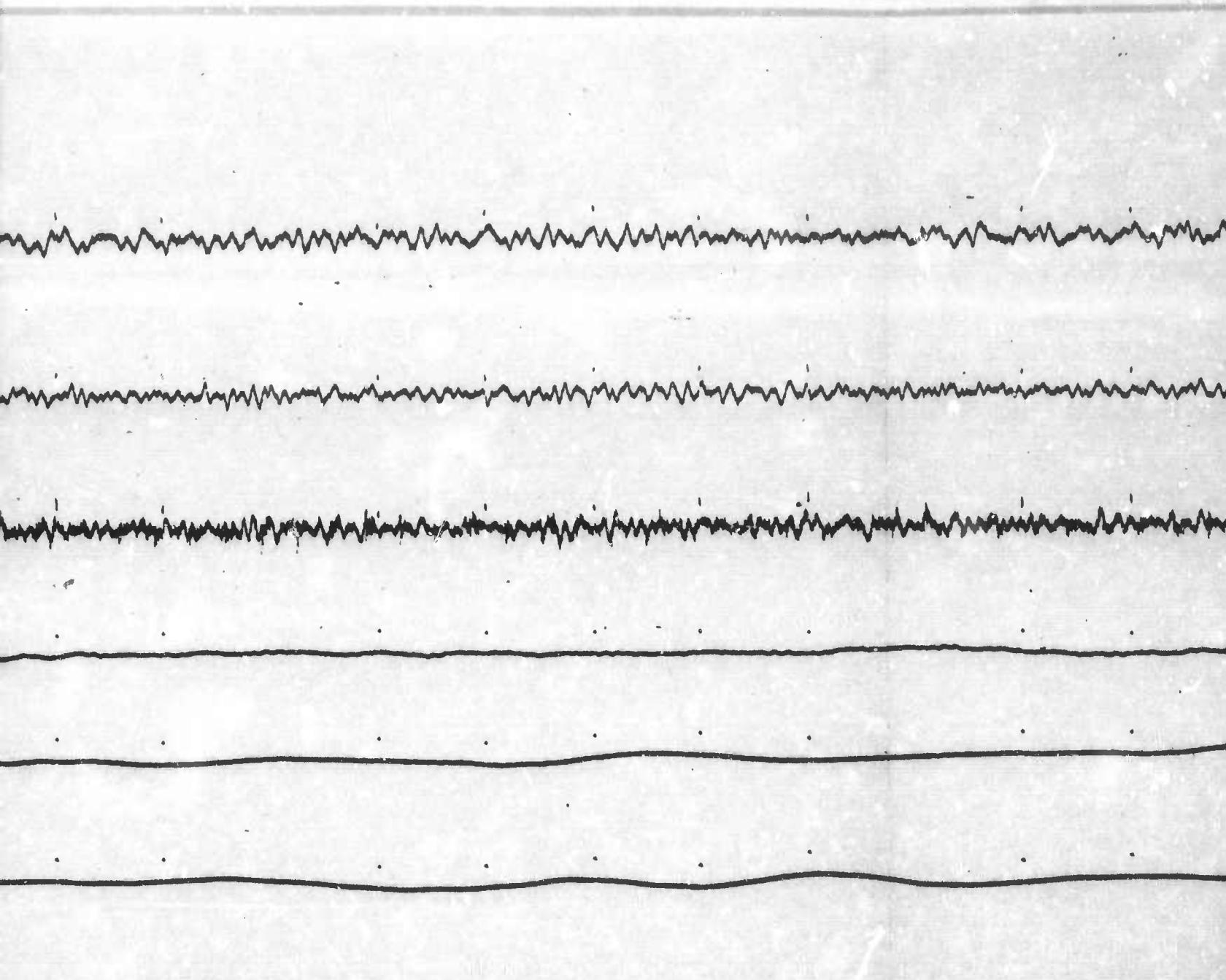
2



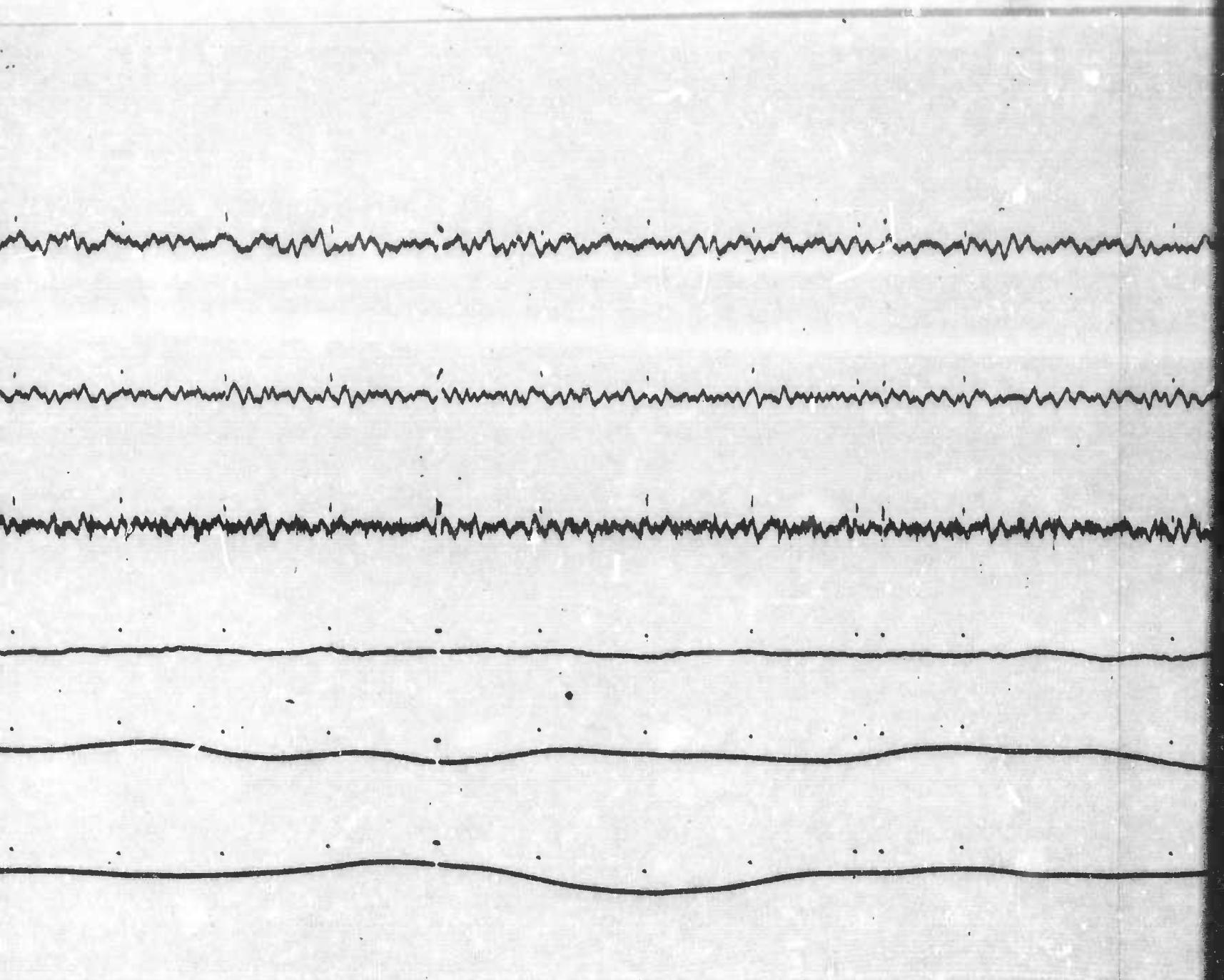
3



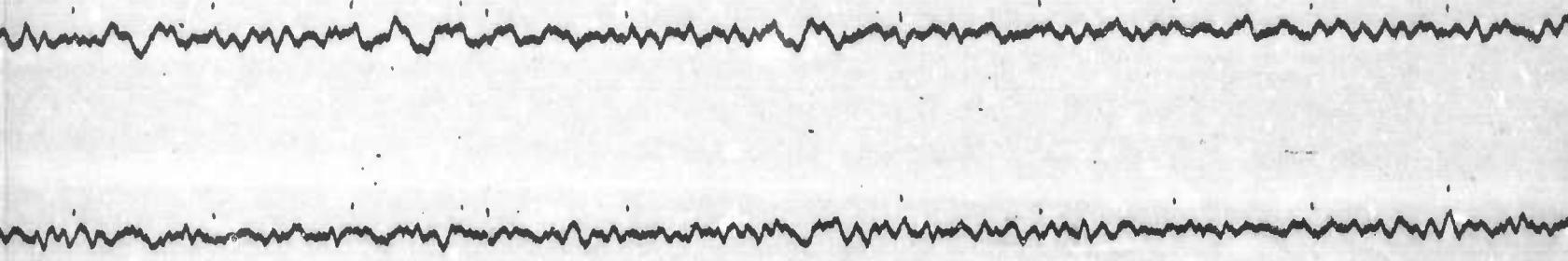
4

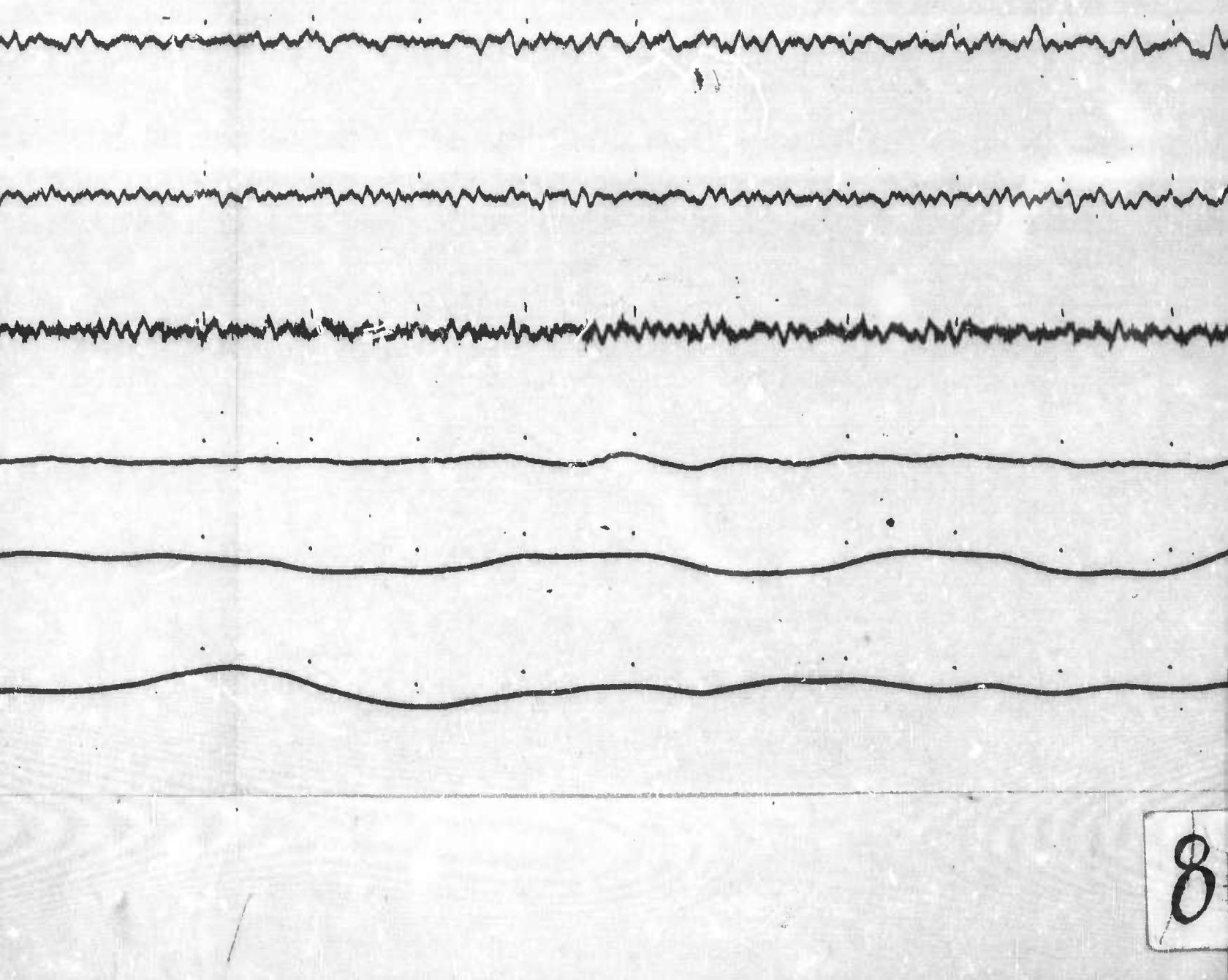


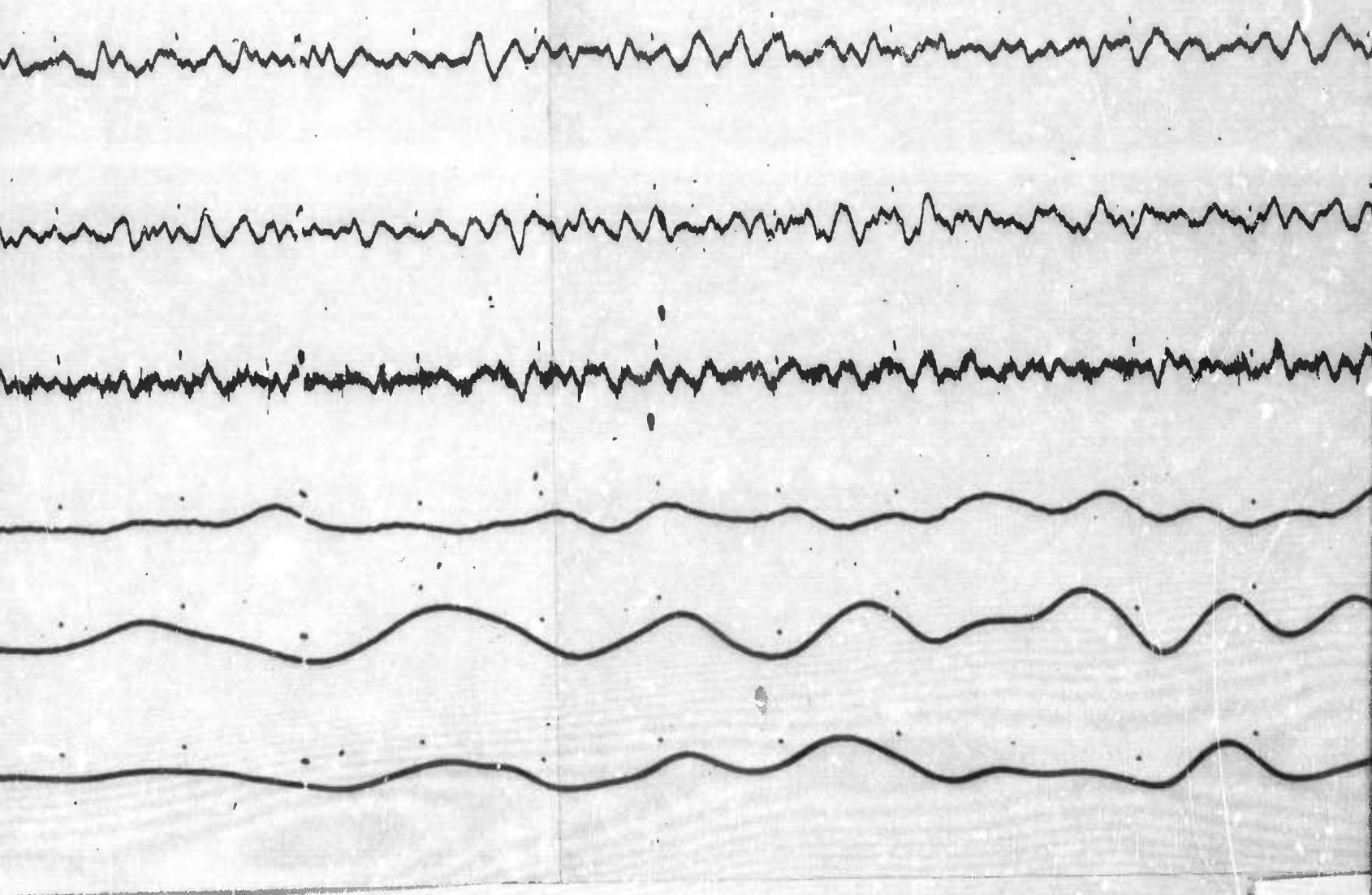
5



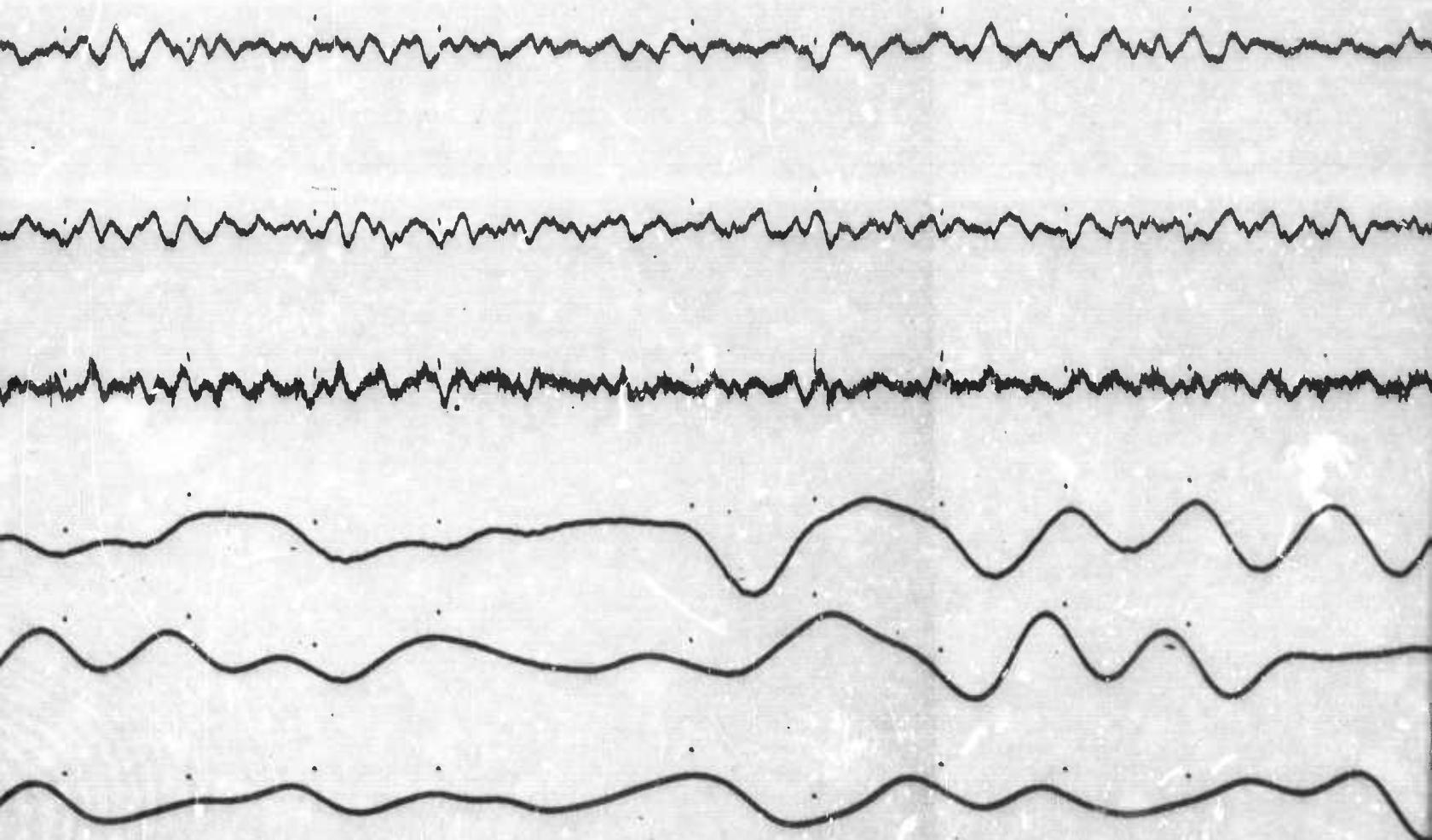
6



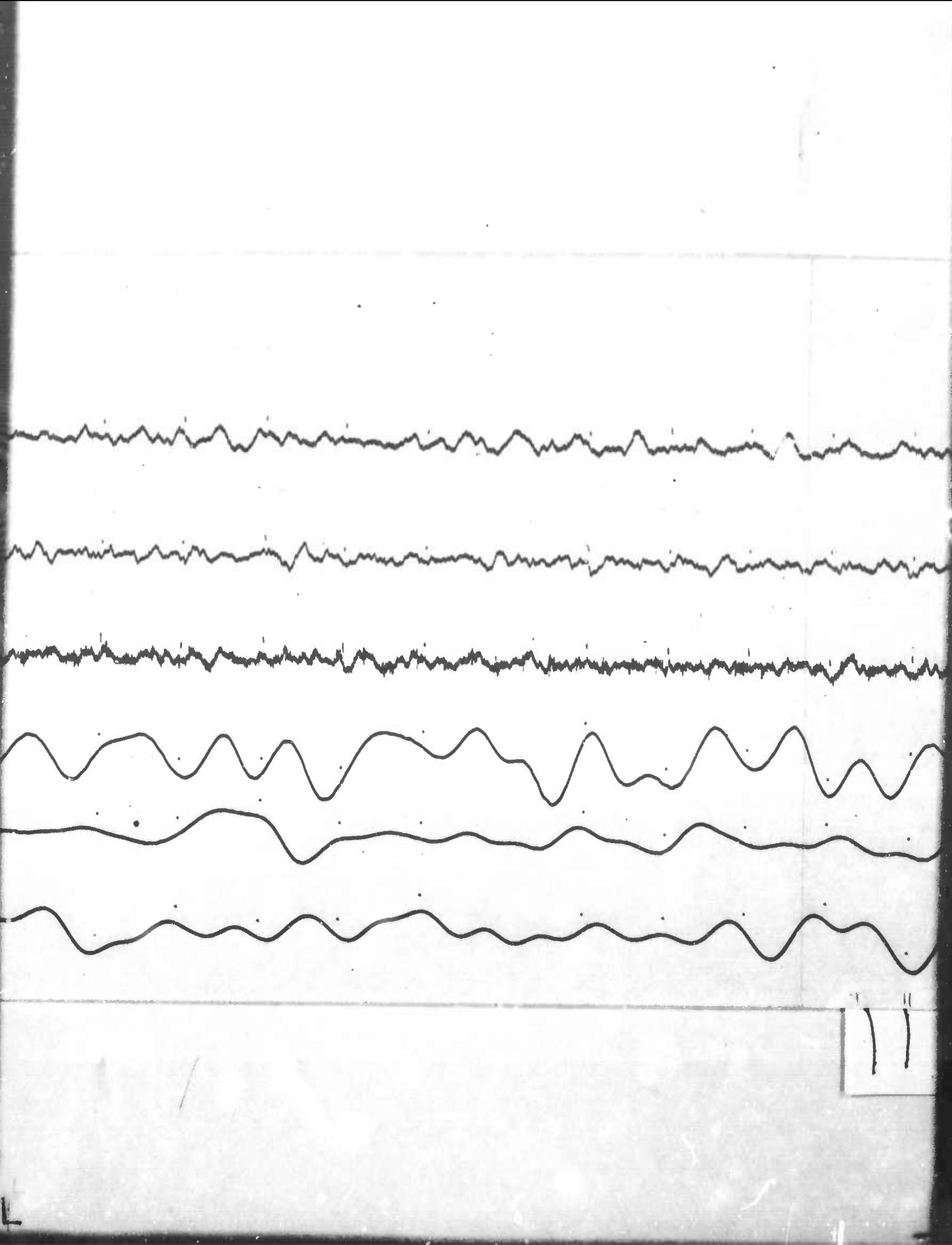


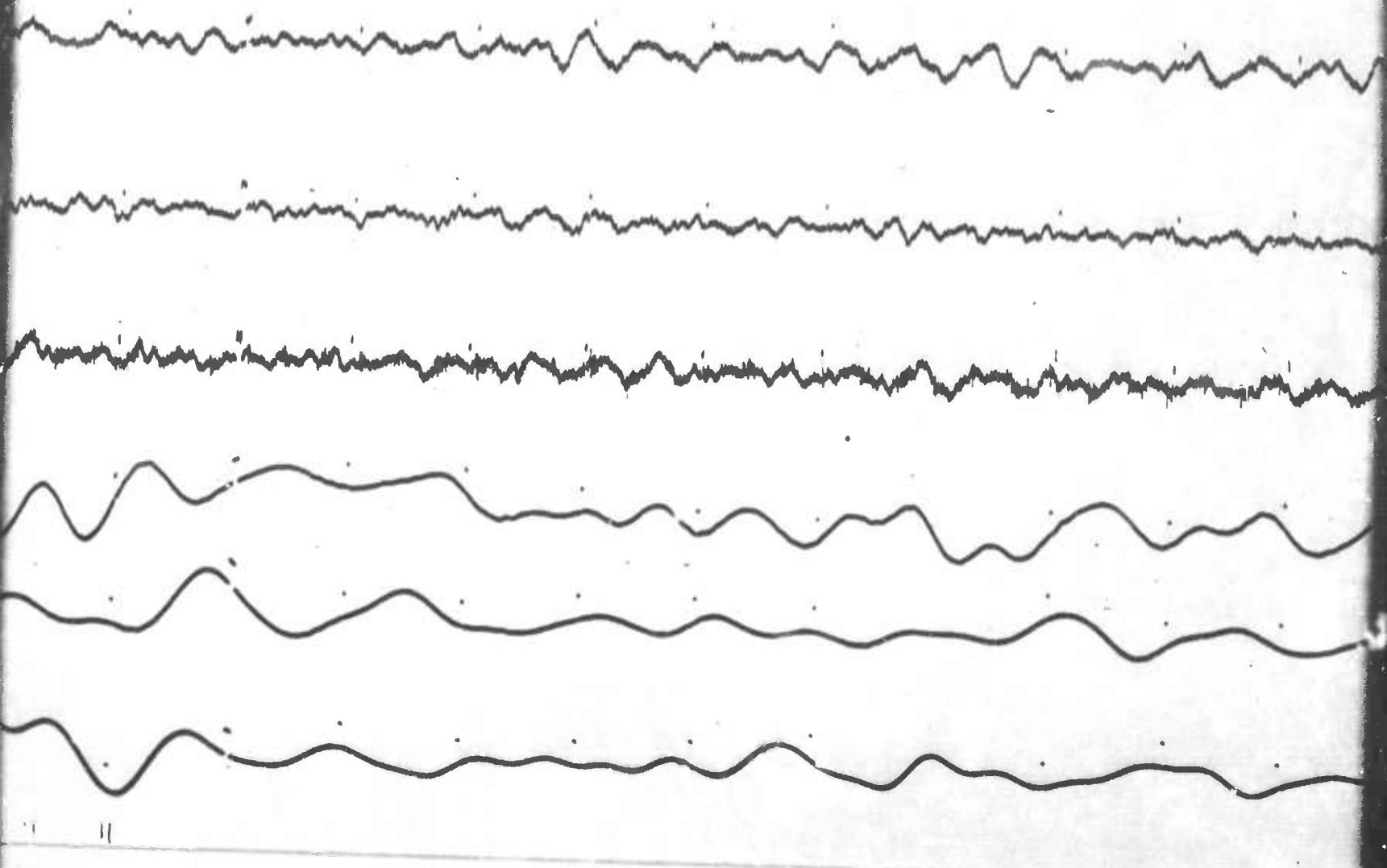


9



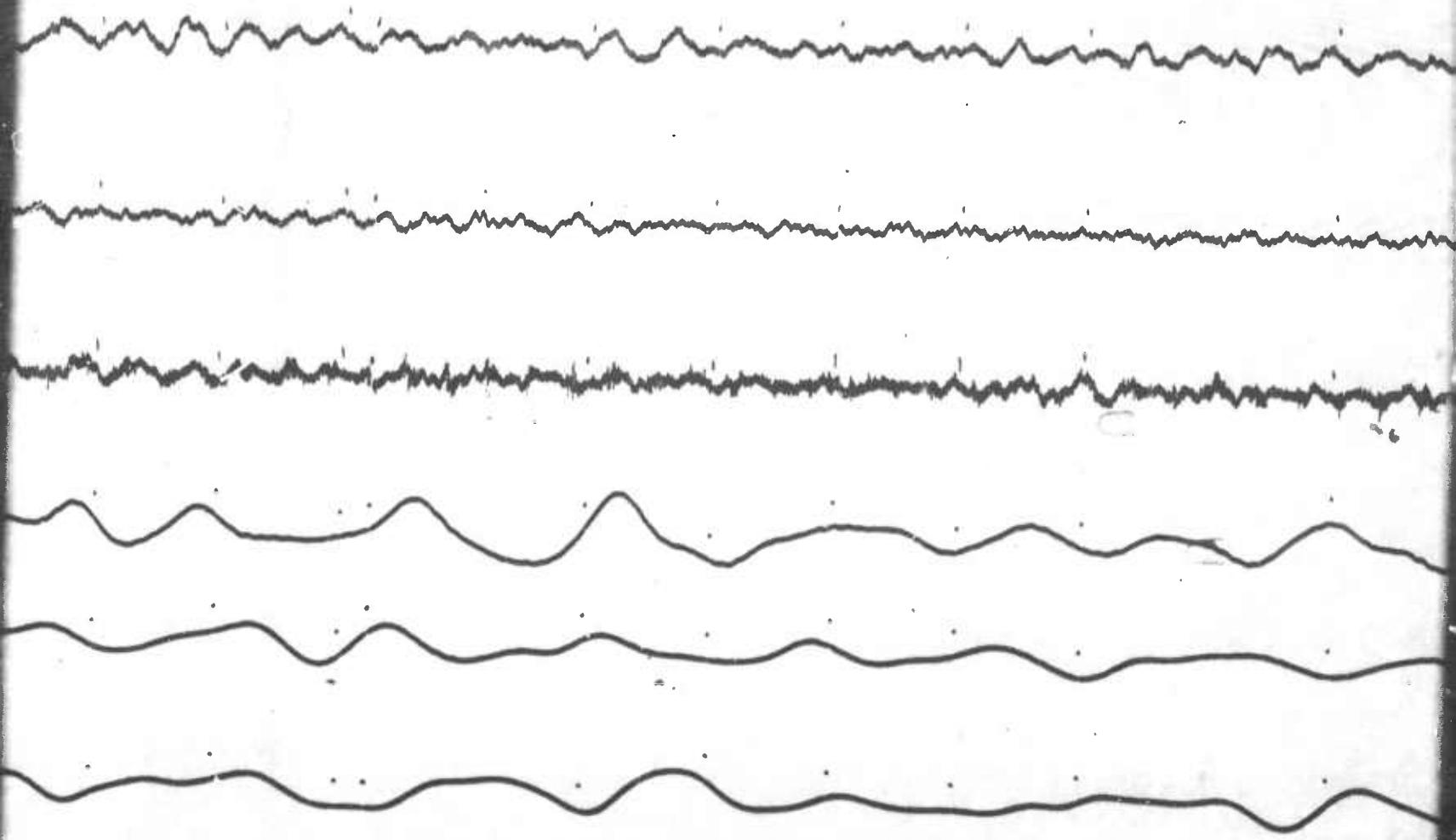
10



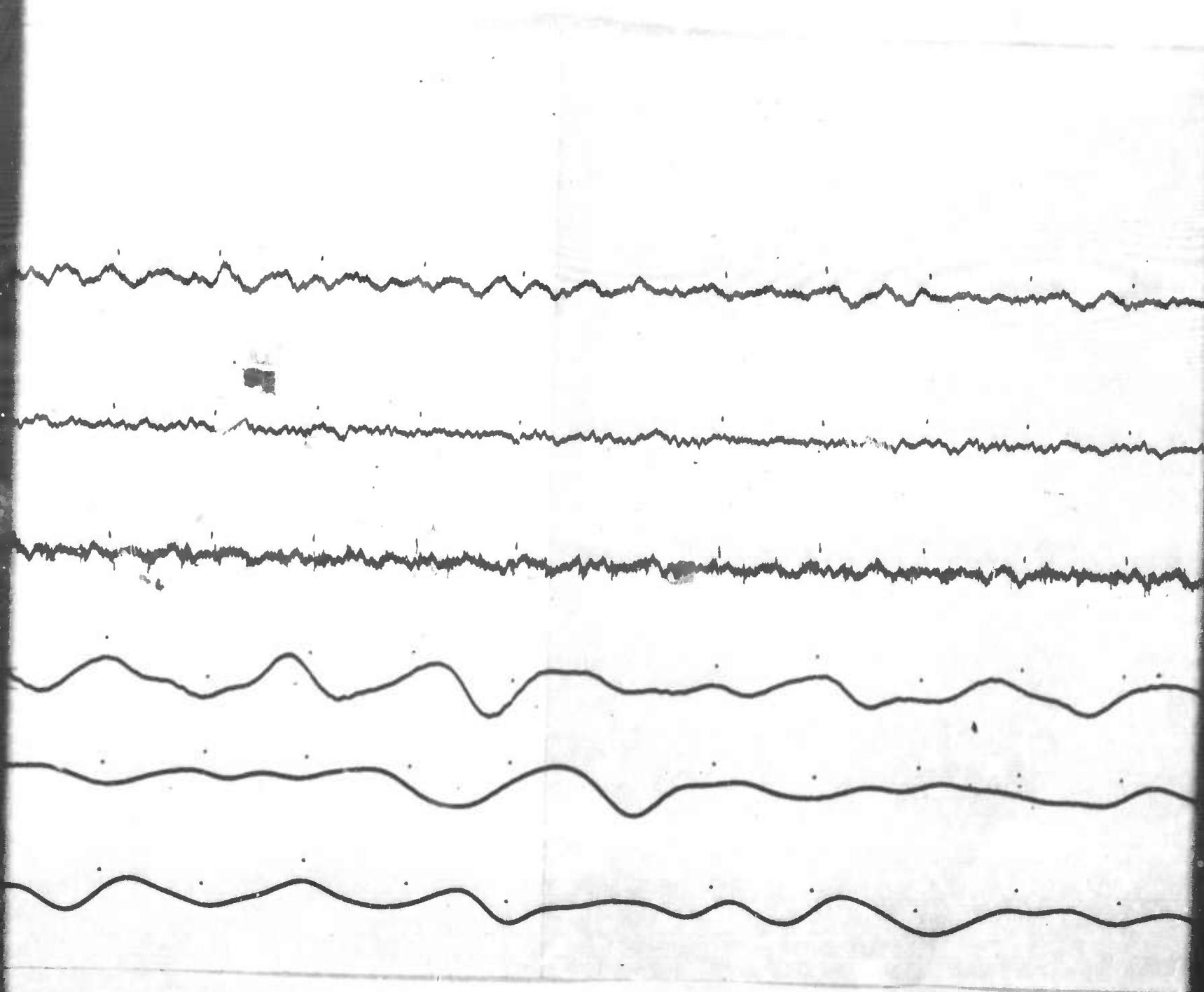


1

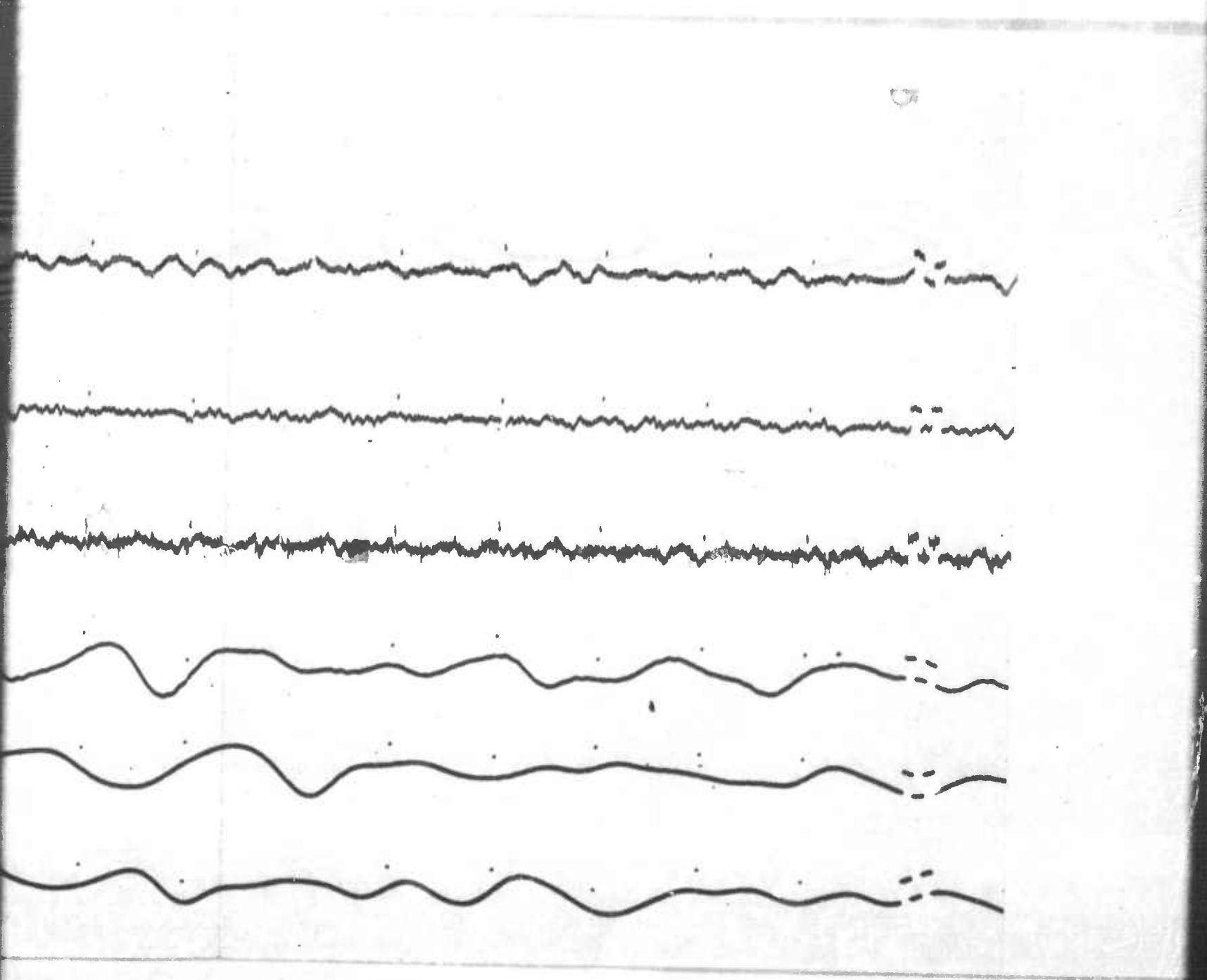
12



13



14



15